

#2

FIG. 1A

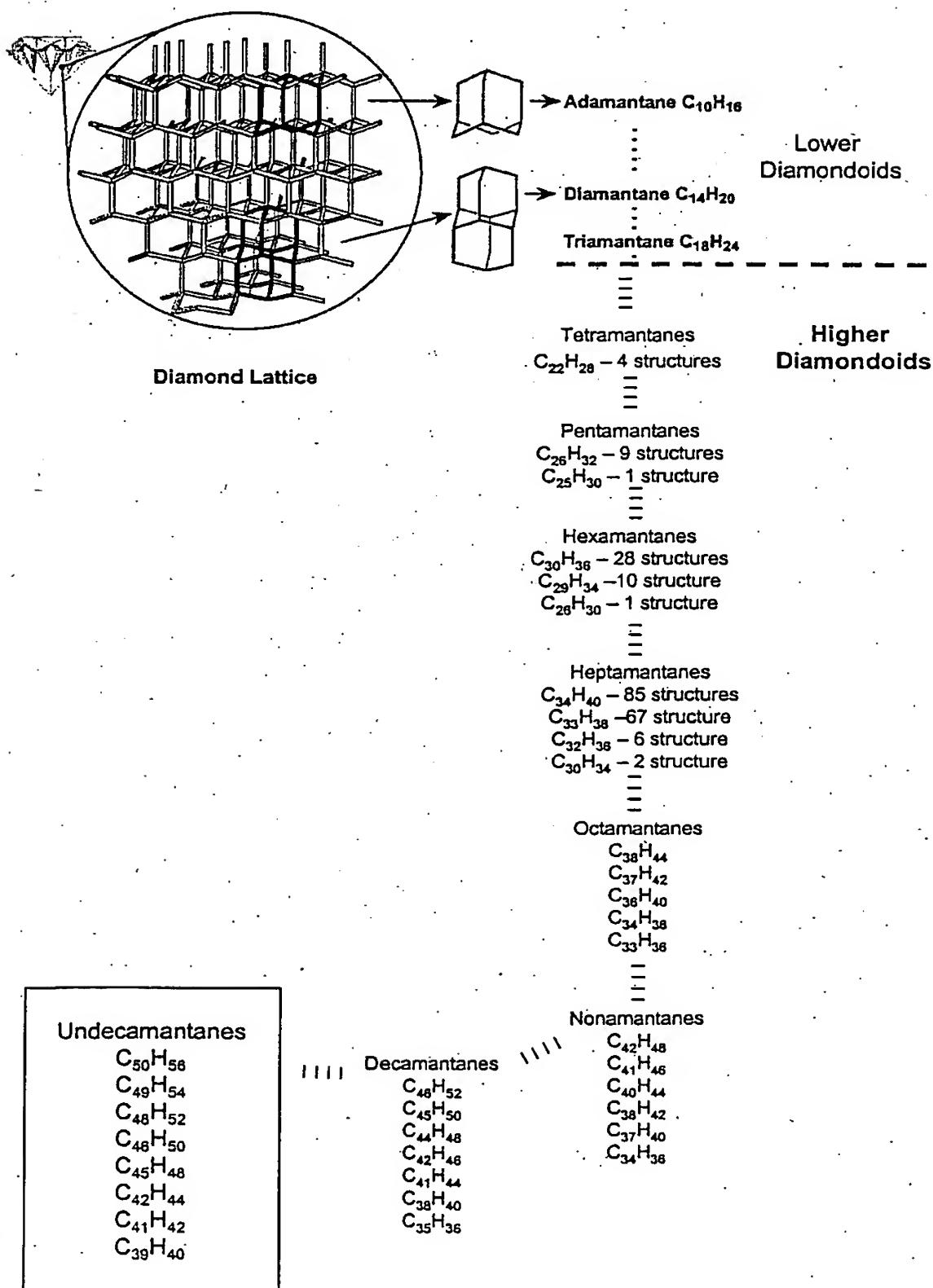
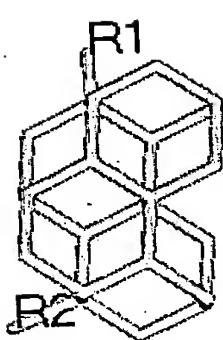
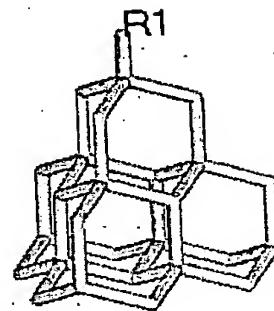
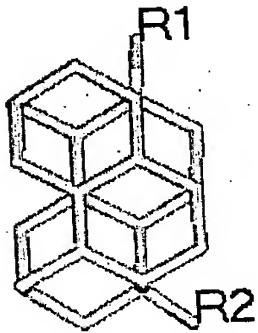


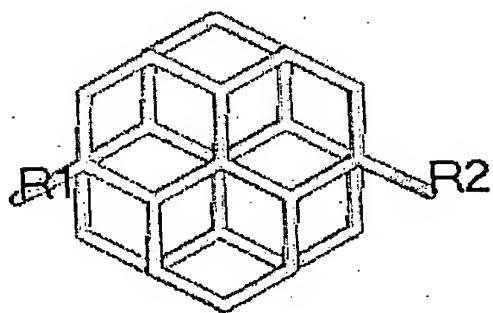
FIG. 1B



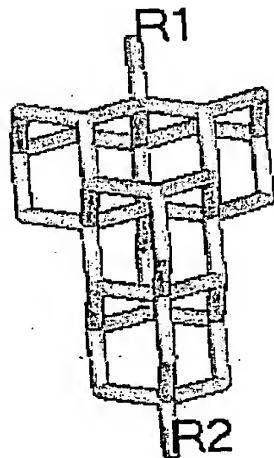
Enantiomeric [123] Tetramantanes



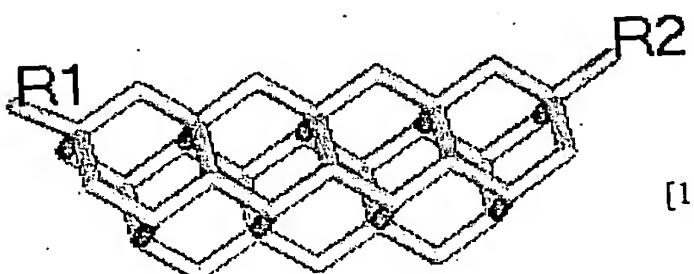
[1(2,3)4] Pentamantane



[12312] Hexamantane
(Cyclohexamantane)

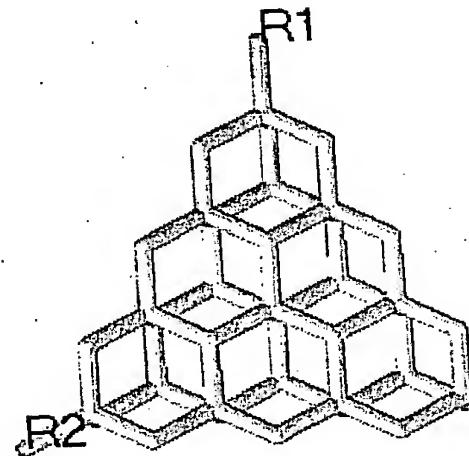
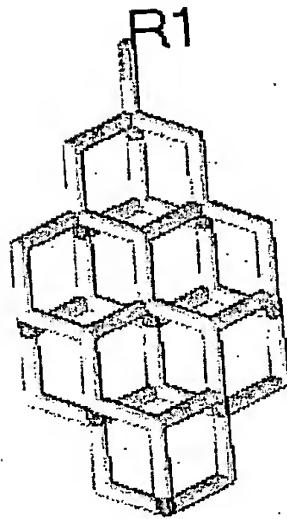


[121(3)4] Hexamantane



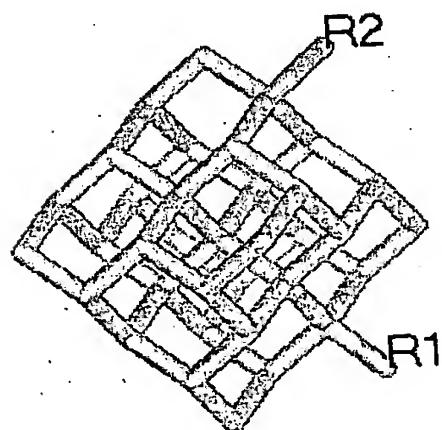
[121212] Heptamantanes

FIG. 1B
(continued)

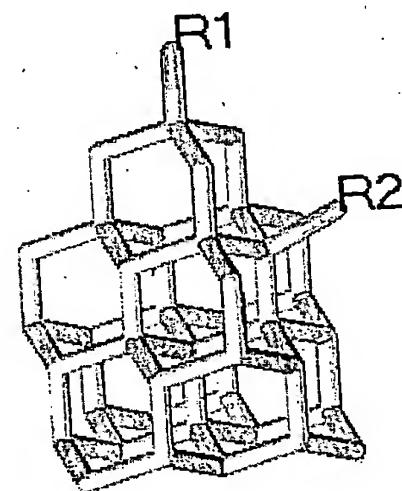


[1213(1)21] Octamantane

[121(2)32(1)3] Nonamantane



[1231241(2)3] Decamantane



[123(1,2)42143] Undecamantane

FIG. 2A

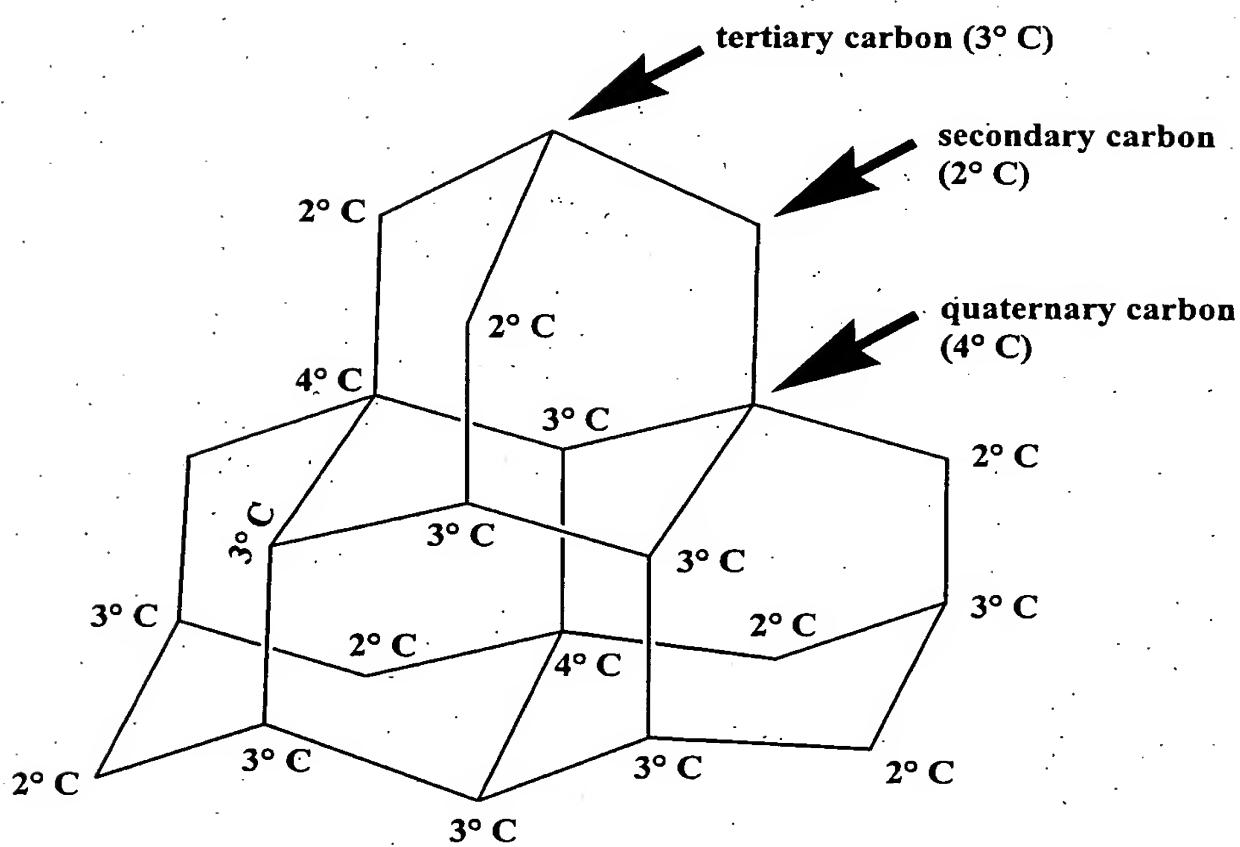
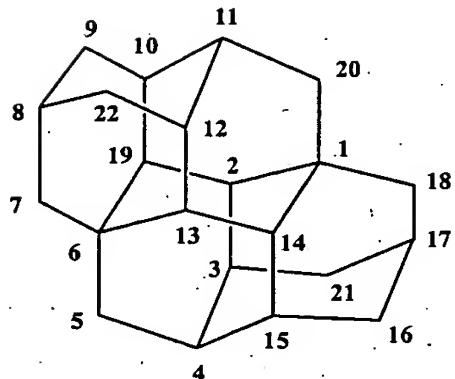
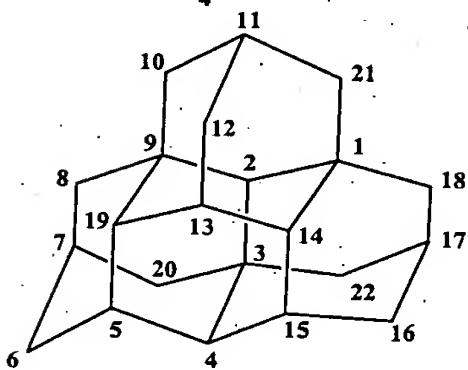


FIG. 2B



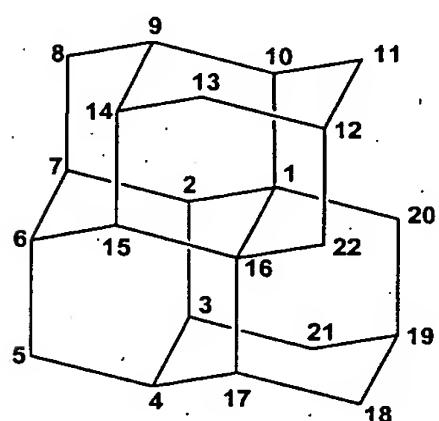
[121] Tetramantane (*anti*-)
 4 non-equivalent tertiary carbons:

4, 11 (equivalent)
 8, 17 (equivalent)
 3, 10, 12, 15 (equivalent)
 2, 13, 14, 19 (equivalent)



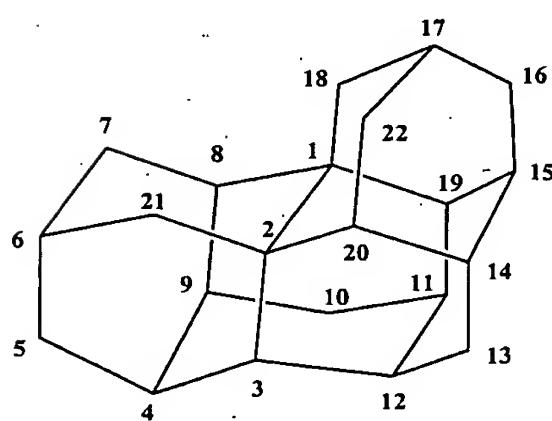
[121]3 Tetramantane (*iso*-)
 4 non-equivalent tertiary carbons:

2
 4, 14, 19 (equivalent)
 5, 13, 15 (equivalent)
 7, 11, 17 (equivalent)



[123]A Tetramantane (*skew-A*)
 6 non-equivalent tertiary carbons:

6, 7 (equivalent)
 4, 9 (equivalent)
 3, 14 (equivalent)
 2, 15 (equivalent)
 10, 17 (equivalent)
 12, 19 (equivalent)



[123]B Tetramantane (*skew-B*)
 6 non-equivalent tertiary carbons:

6, 17 (equivalent)
 4, 15 (equivalent)
 11, 12 (equivalent)
 3, 19 (equivalent)
 9, 14 (equivalent)
 8, 20 (equivalent)

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FIG. 2C

Pentamantane

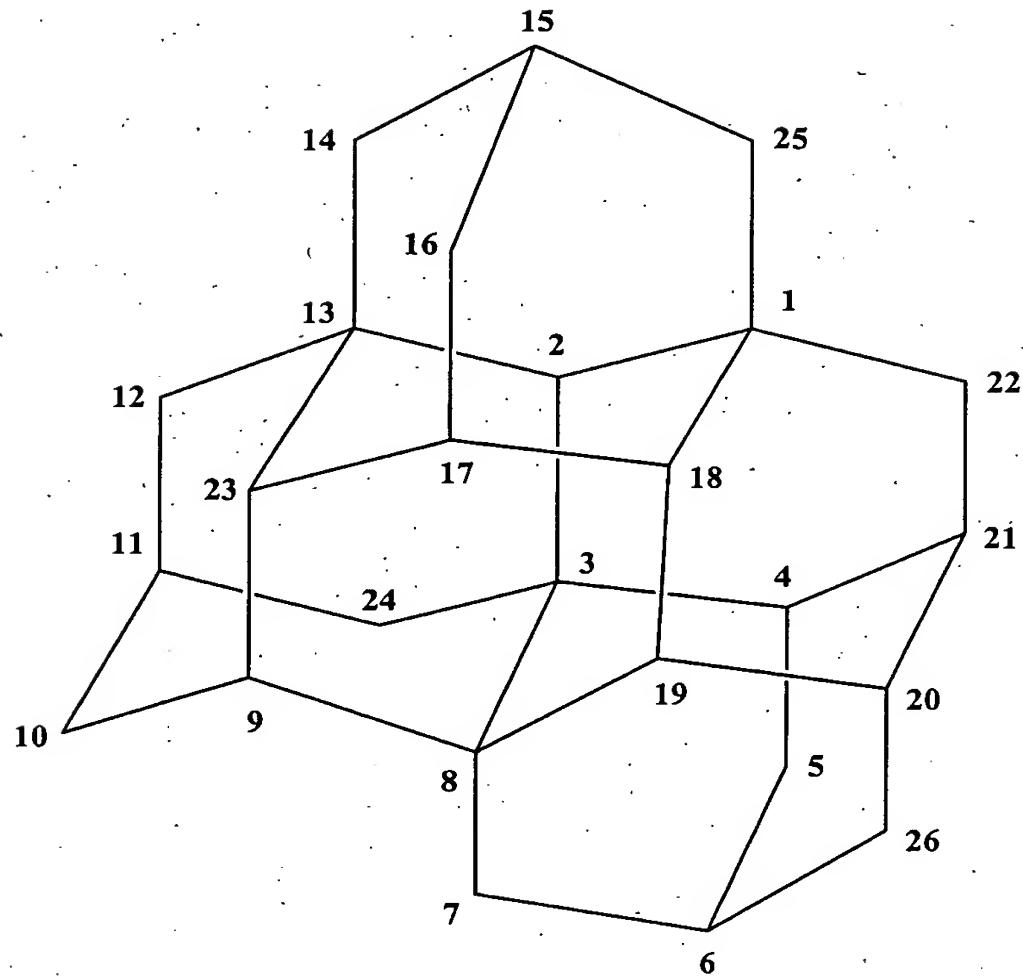


FIG. 2D

Hexamantane

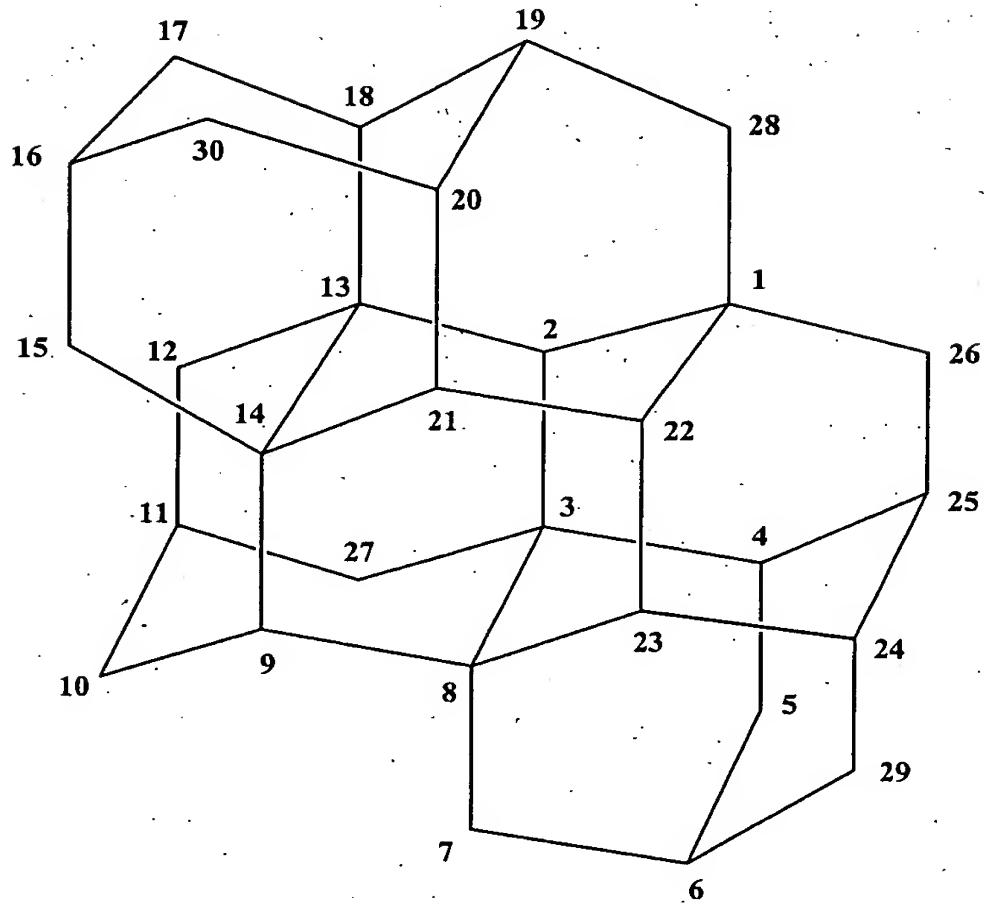
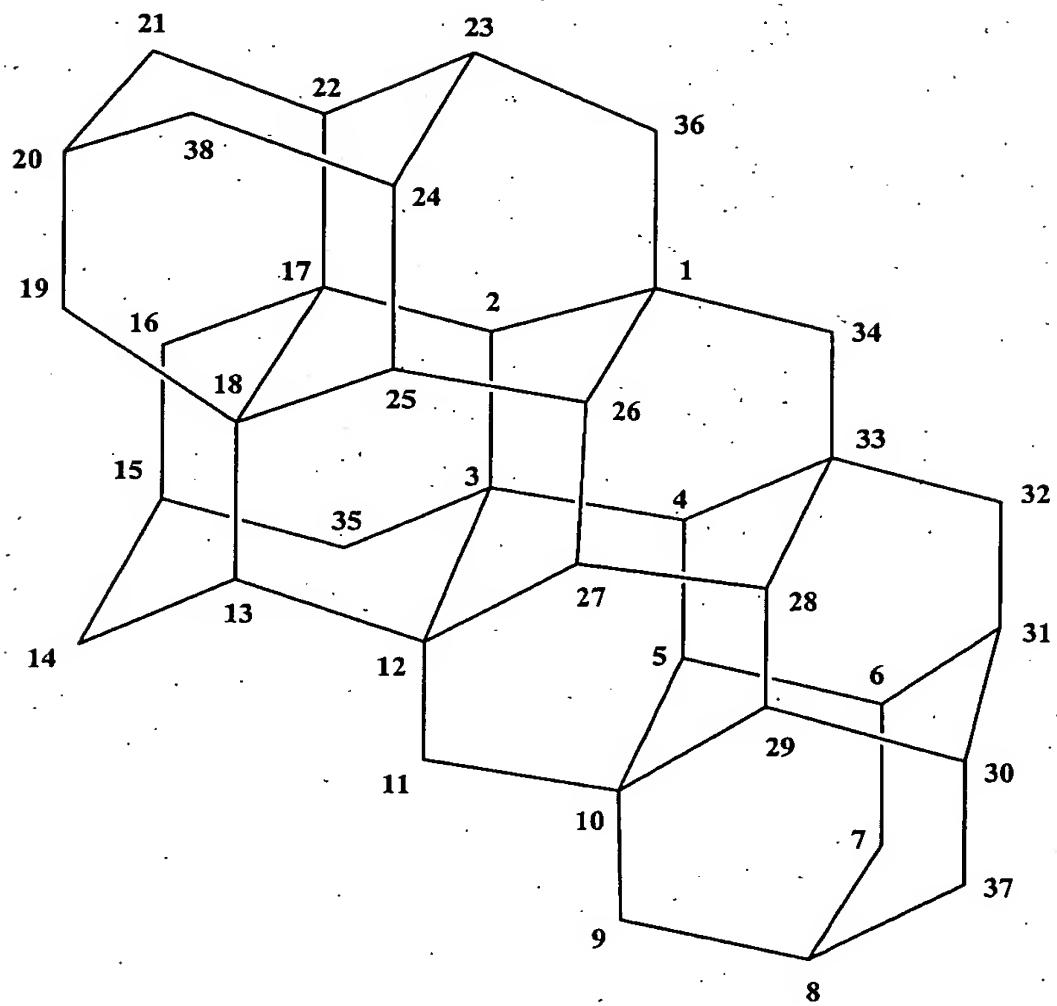


FIG. 2E

Octamantane



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FIG. 2F

Undecamantane

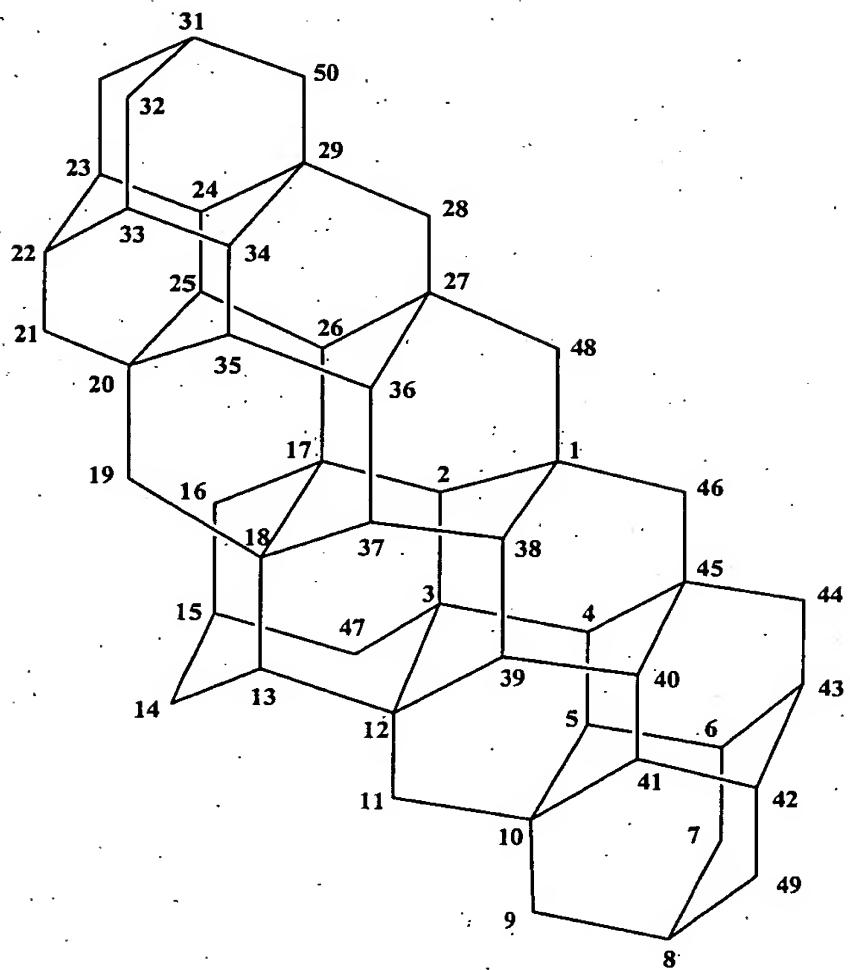


FIG. 3A

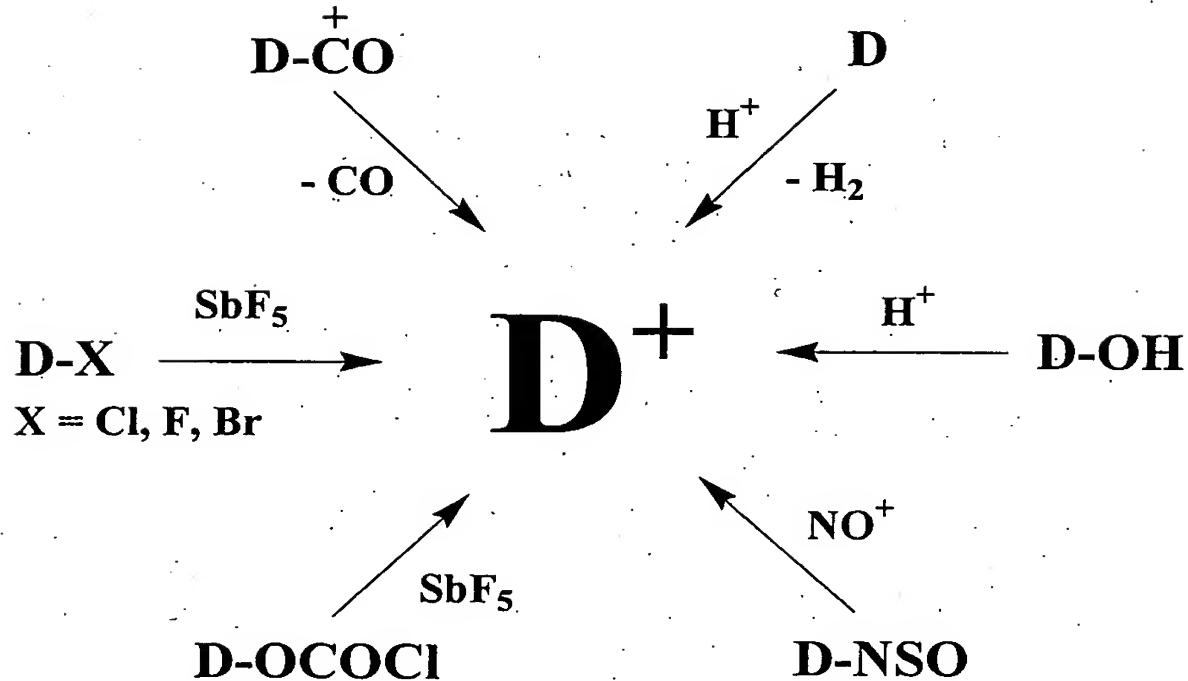


FIG. 3B

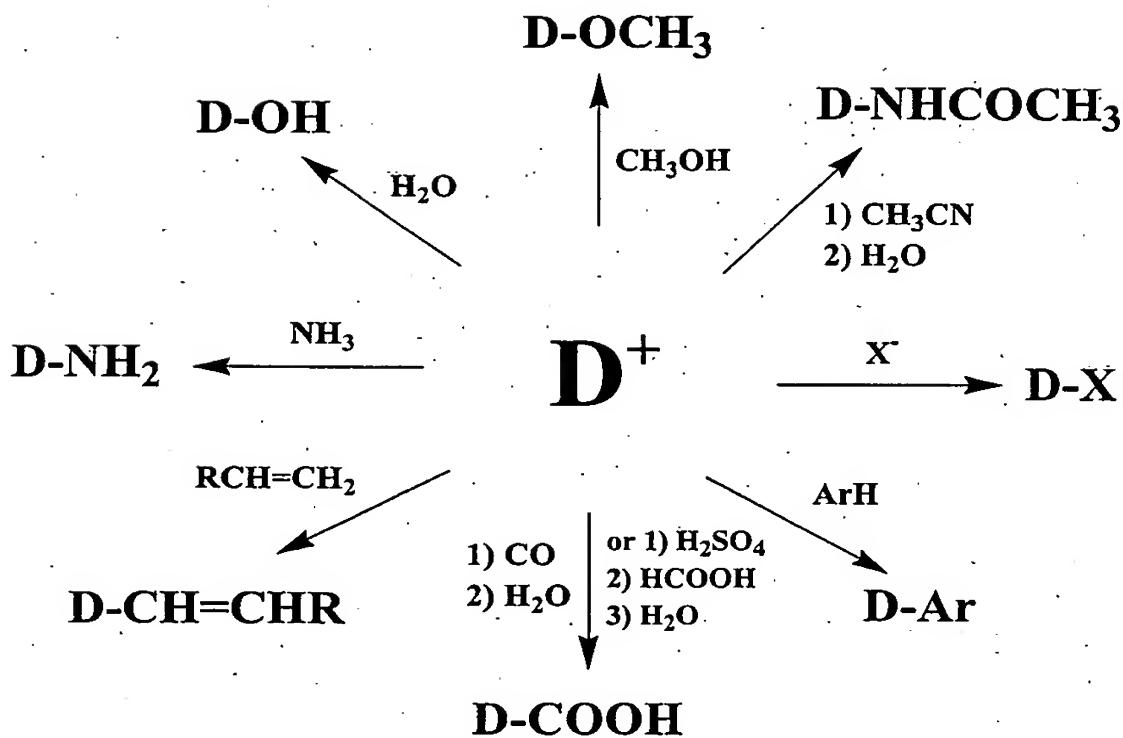


FIG. 3C

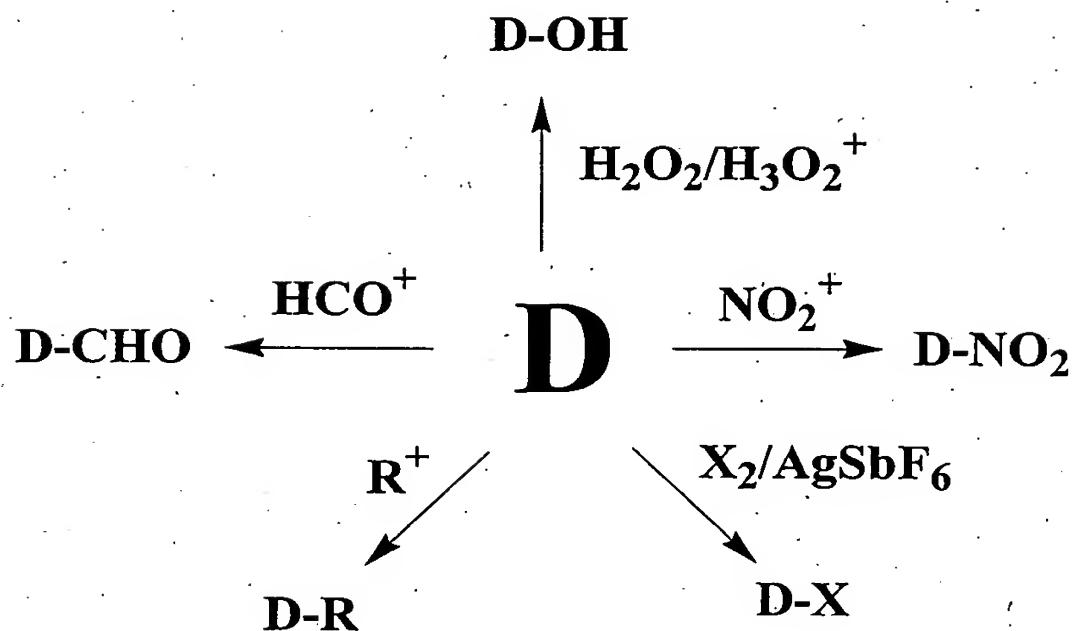


FIG. 4A

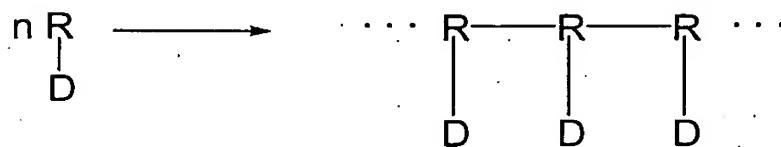


FIG. 4B

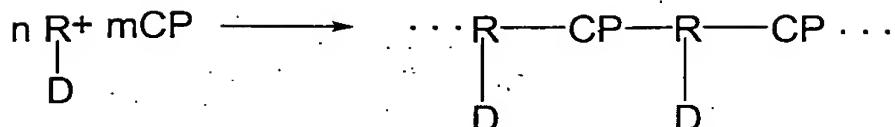


FIG. 4C

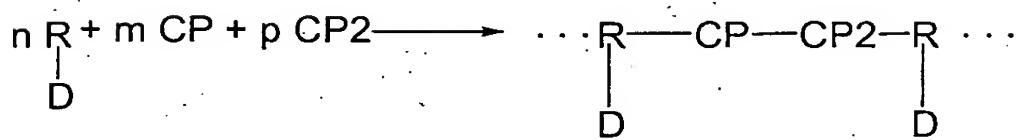


FIG. 4D

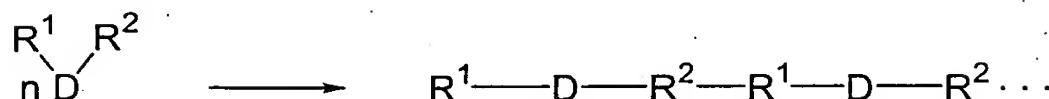
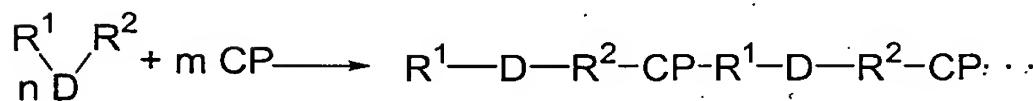


FIG. 4E



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FIG. 4F

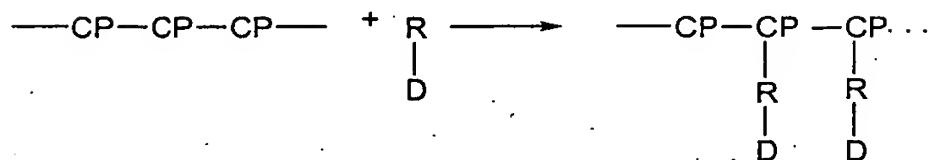


FIG. 4G

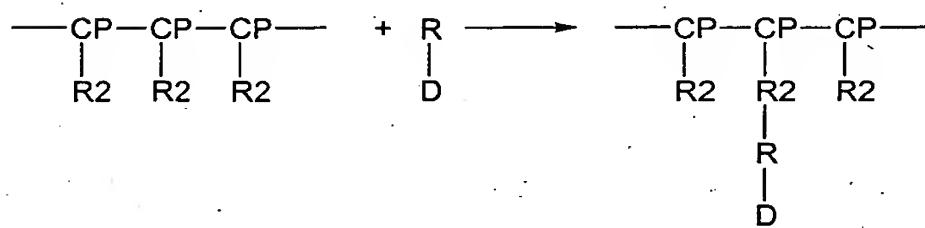


FIG. 4H

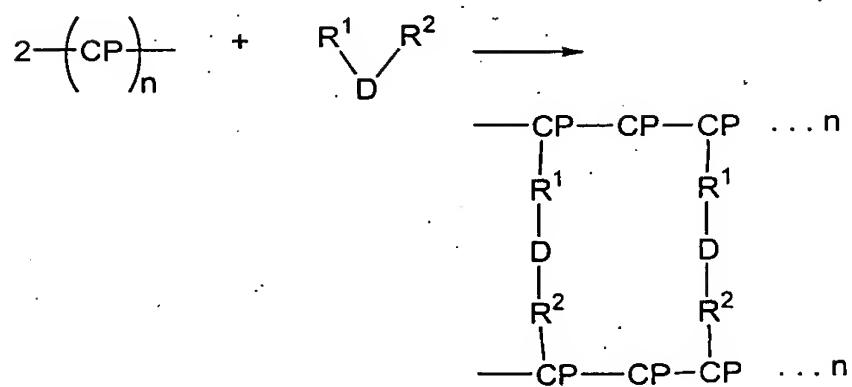
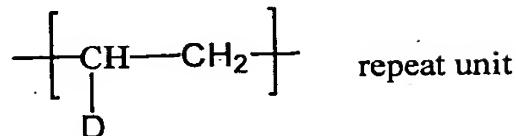


FIG. 4I

Polyvinyl

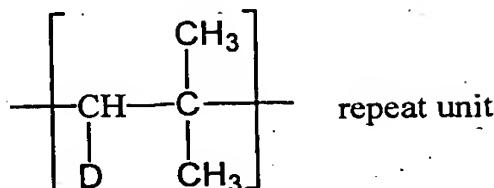
D-CH=CH₂
monomer



Further vinyl addition polymers

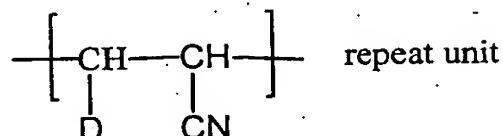
isobutylene

D-CH=C(CH₃)₂



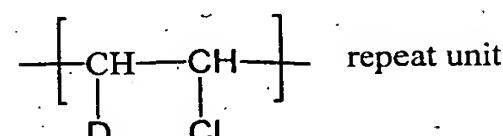
acryonitrile

D-CH=CH-CN



v vinylchloride

D-CH=CH-Cl



acrylates

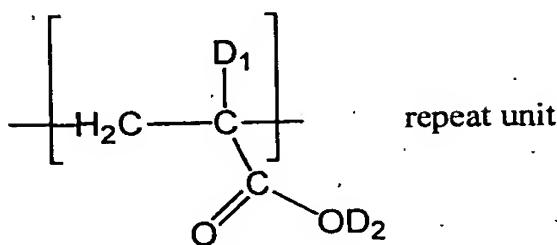
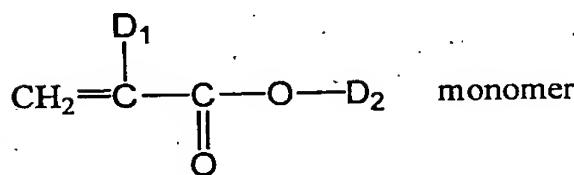
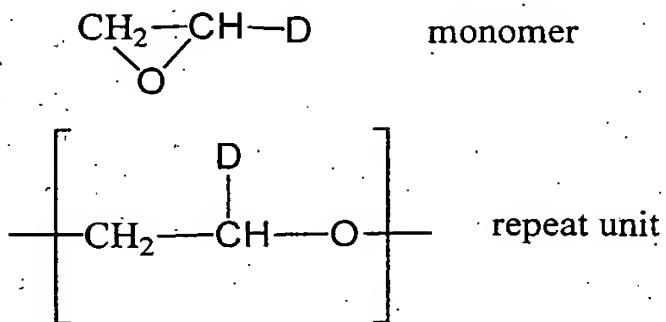


FIG. 4I (cont.)

Further addition polymers

Polyethylene oxide



Polyacetaldehyde

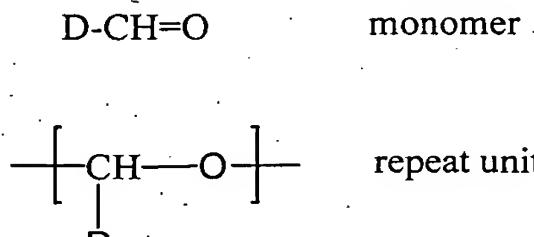


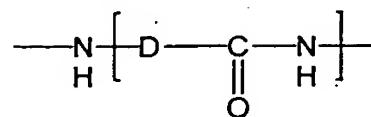
FIG. 4I (cont.)

Condensation polymers

Polyamide

NH₂-D-COOH

1 monomer

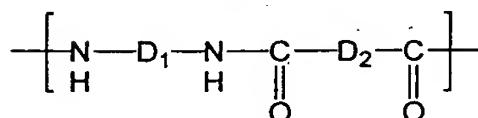


repeat unit

NH₂-D₁-NH₂

HOOC-D₂-COOH

2 monomers

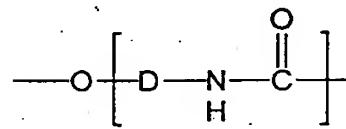


repeat unit

Polyurethane

HO-D-N=C=O

1 monomer

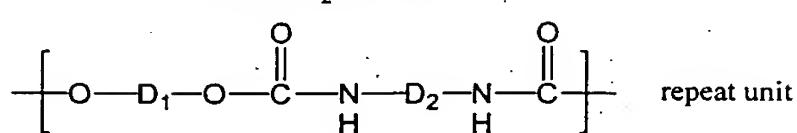


repeat unit

HO-D₁-OH

O=C=N-D₂-N=C=O

2 monomers



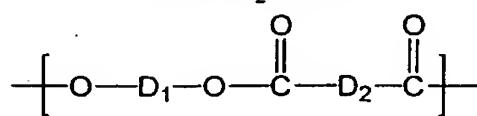
repeat unit

Polyester

HO-D₁-OH

HOOC-D₂-COOH

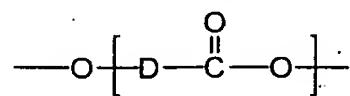
2 monomers



repeat unit

HO-D-COOH

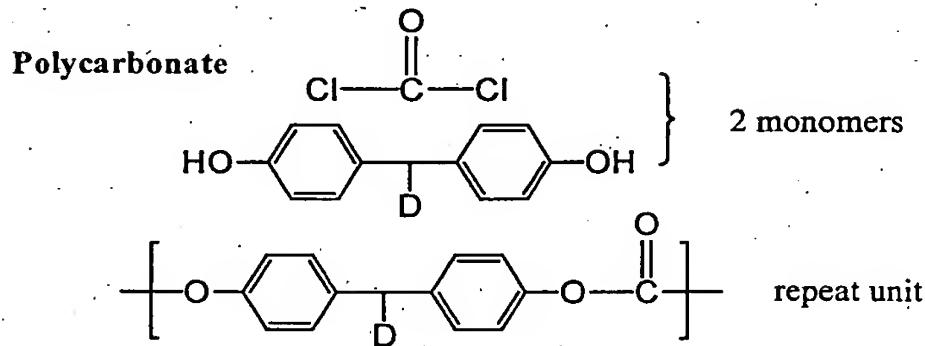
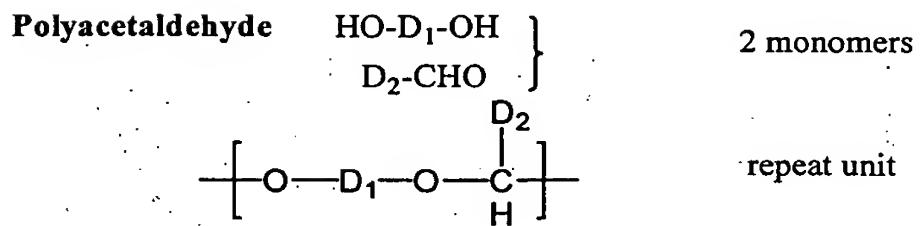
1 monomer



repeat unit

FIG. 4I (cont.)

Condensation polymers (cont.)



Epoxy resins (based on epichlorohydrin - bisphenol A resins)

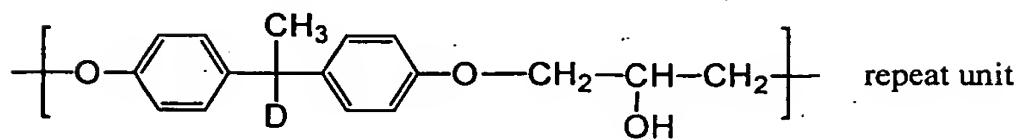
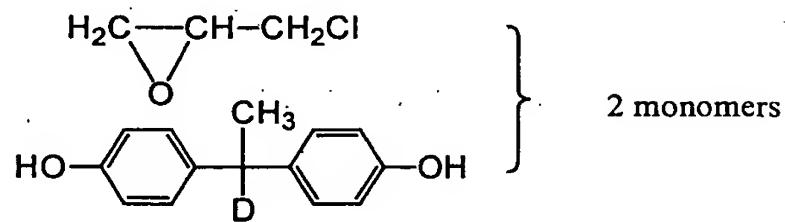
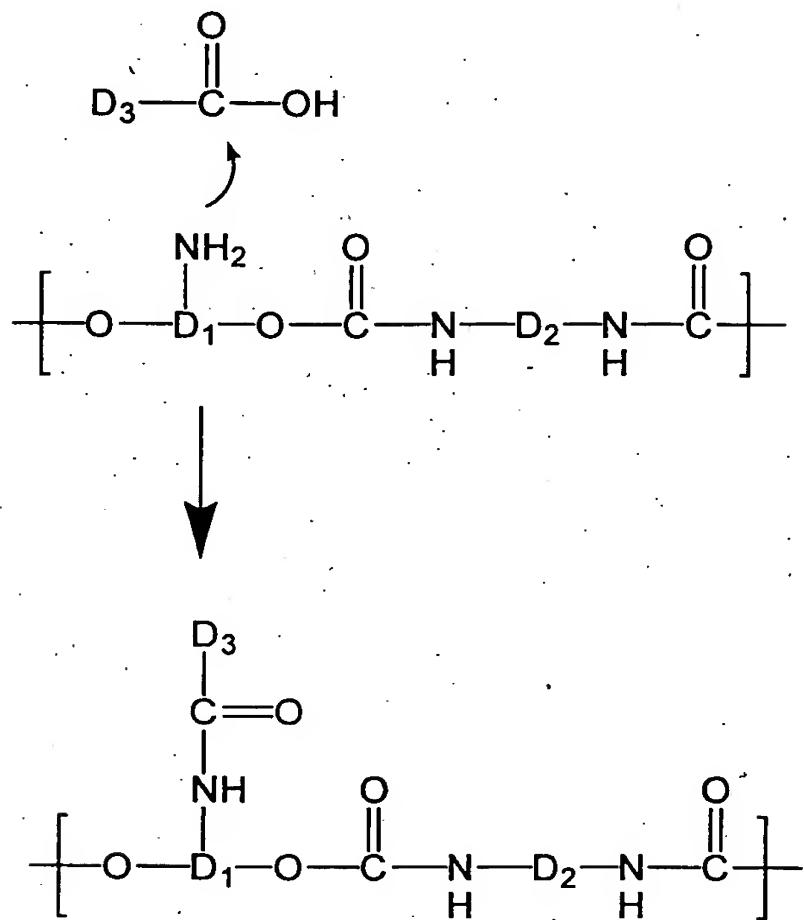


FIG. 4I (cont.)

Diamondoid-containing graft polymer



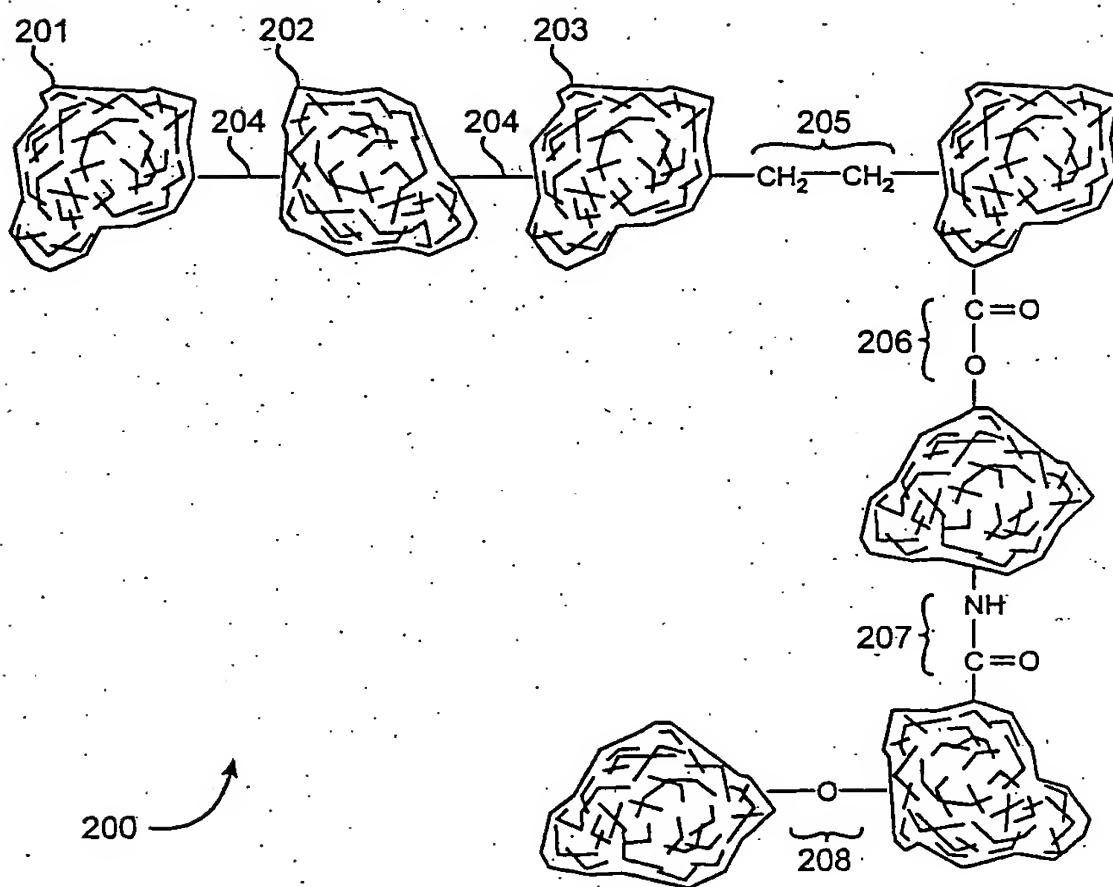


FIG. 5A

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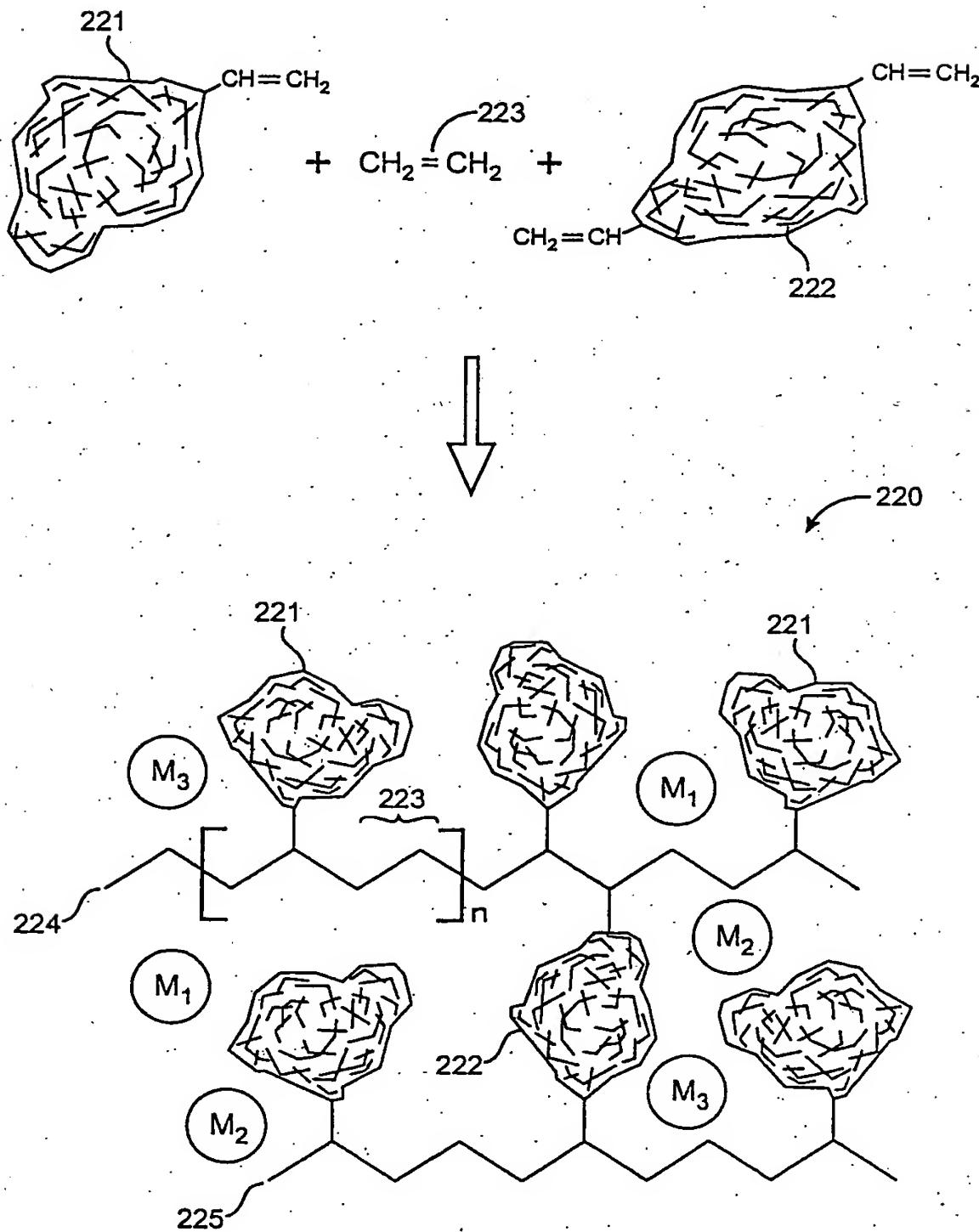


FIG. 5B

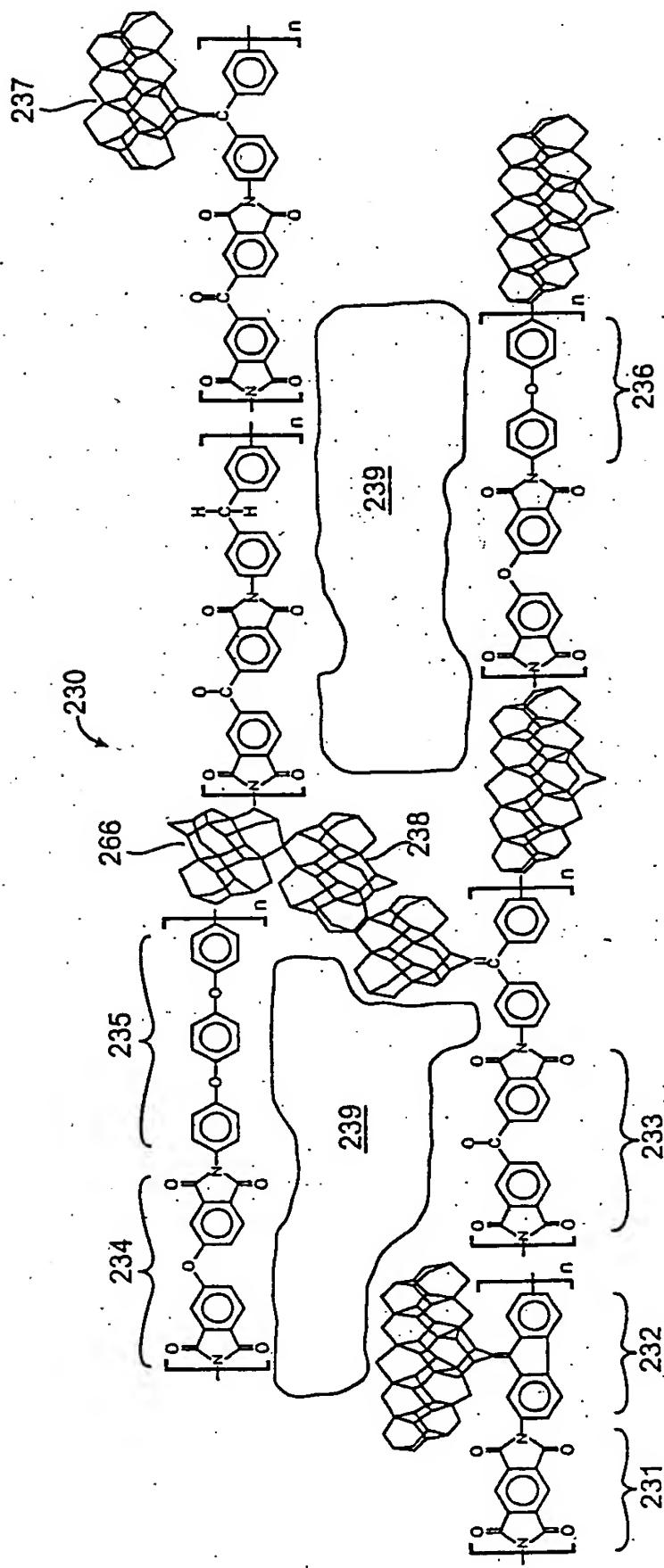


FIG. 5C

Decreasing Rigidity of Cross-linked Materials

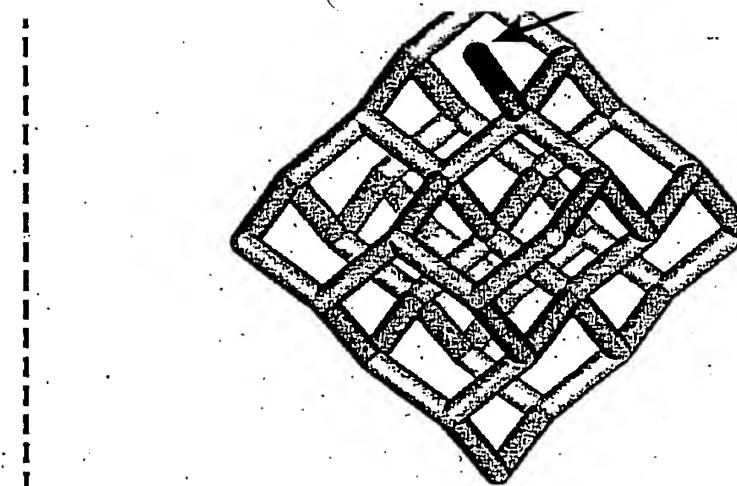


FIG. 5D

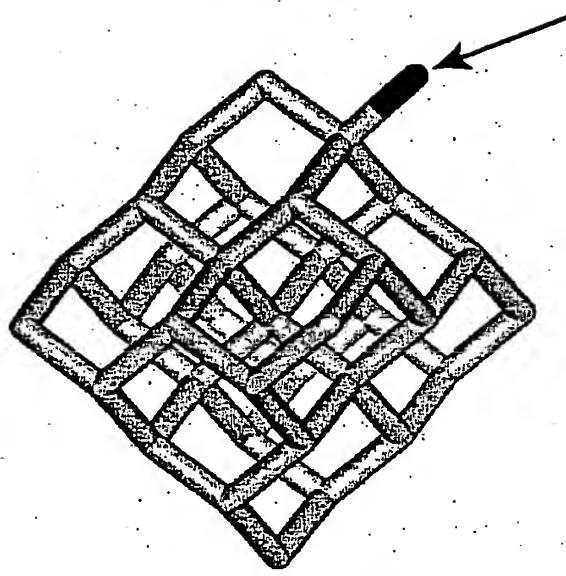


FIG. 5E

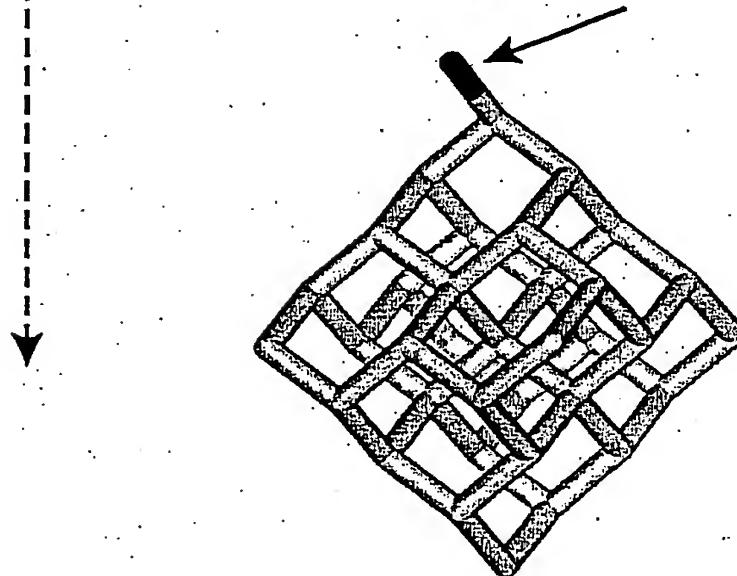


FIG. 5F

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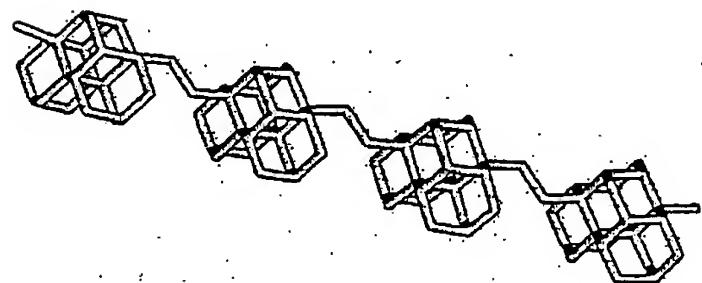


FIG. 5G

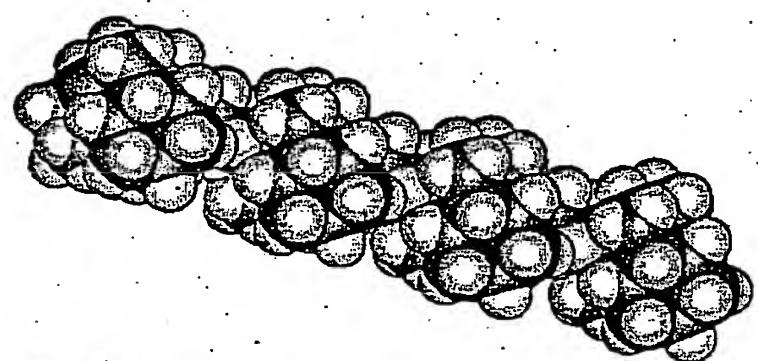
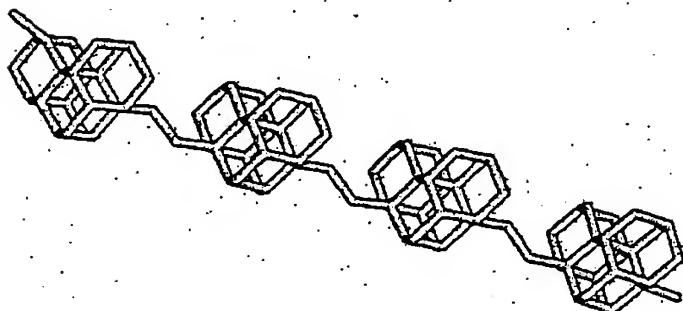


FIG. 5H

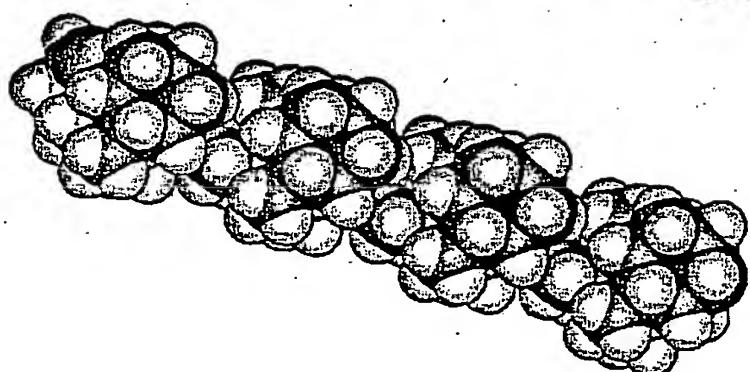


FIG. 6

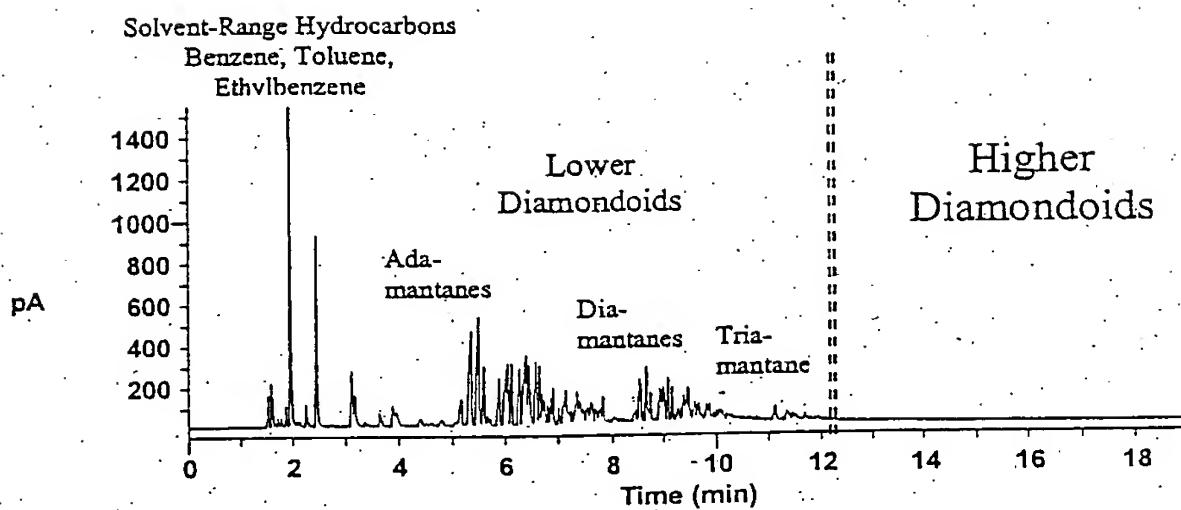


FIG. 7

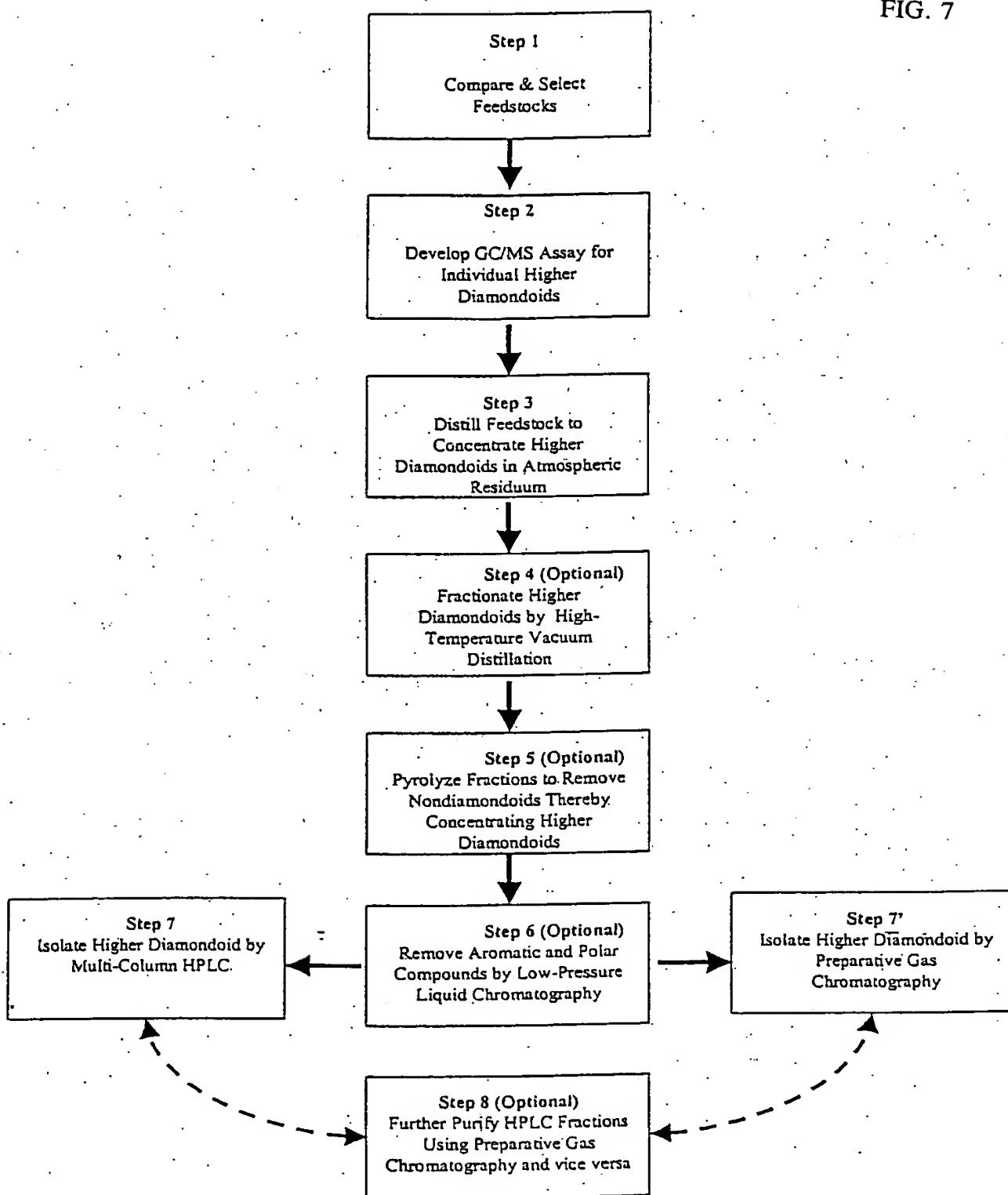


FIG. 8A

| Higher Diamondoid | Compound Reference Number | M+ (m/z) (Equals Base Peak) | GC/MS Retention Times* (min.) | GC/MS Relative Retention Times** (min.) |
|-------------------|---------------------------|-----------------------------|-------------------------------|---|
| Tetramantane #1 | 4-1 | 292 | 8.10 | 1.00 |
| Tetramantane #2 | 4-2 | 292 | 8.66 | 1.07 |
| Tetramantane #3 | 4-3 | 292 | 9.12 | 1.13 |
| Pentamantane #1 | 5-1 | 344 | 10.40 | 1.28 |
| Pentamantane #2 | 5-2 | 344 | 11.93 | 1.47 |
| Pentamantane #3 | 5-3 | 344 | 11.98 | 1.48 |
| Pentamantane #4 | 5-4 | 344 | 12.38 | 1.53 |
| Pentamantane #5 | 5-5 | 344 | 12.50 | 1.54 |
| Pentamantane #6 | 5-6 | 344 | 12.71 | 1.57 |
| Cyclohexamantane | C-6 | 342 | 12.34 | 1.52 |
| Hexamantane #1 | 6-1 | 396 | 14.46 | 1.78 |
| Hexamantane #2 | 6-2 | 396 | 14.61 | 1.80 |
| Hexamantane #3 | 6-3 | 396 | 14.97 | 1.85 |
| Hexamantane #4 | 6-4 | 396 | 14.99 | 1.85 |
| Hexamantane #5 | 6-5 | 396 | 15.04 | 1.86 |
| Hexamantane #6 | 6-6 | 396 | 15.13 | 1.87 |
| Hexamantane #7 | 6-7 | 396 | 15.22 | 1.88 |
| Hexamantane #8 | 6-8 | 396 | 15.32 | 1.89 |
| Hexamantane #9 | 6-9 | 396 | 15.42 | 1.90 |
| Hexamantane #10 | 6-10 | 396 | 15.45 | 1.91 |
| Hexamantane #11 | 6-11 | 396 | 15.49 | 1.91 |
| Hexamantane #12 | 6-12 | 396 | 15.54 | 1.92 |
| Hexamantane #13 | 6-13 | 396 | 15.60 | 1.93 |
| Hexamantane #14 | 6-14 | 396 | 15.81 | 1.95 |
| Hexamantane #15 | 6-15 | 396 | 15.89 | 1.96 |
| Hexamantane #16 | 6-16 | 396 | 16.05 | 1.98 |
| Hexamantane #17 | 6-17 | 396 | 16.08 | 1.99 |
| Heptamantane #1 | 7-1 | 394 | 14.96 | 1.85 |
| Heptamantane #2 | 7-2 | 394 | 15.53 | 1.92 |
| Heptamantane #3 | 7-3 | 448 | 17.34 | 2.14 |
| Heptamantane #4A | 7-4A | 448 | 17.70 | 2.18 |
| Heptamantane #4B | 7-4B | 448 | 17.70 | 2.18 |
| Heptamantane #5 | 7-5 | 448 | 17.71 | 2.19 |
| Heptamantane #6 | 7-6 | 448 | 17.79 | 2.20 |
| Heptamantane #7 | 7-7 | 448 | 17.82 | 2.20 |
| Heptamantane #8 | 7-8 | 448 | 17.99 | 2.22 |
| Heptamantane #9A | 7-9A | 448 | 18.13 | 2.24 |
| Heptamantane #9B | 7-9B | 448 | 18.13 | 2.24 |
| Heptamantane #9C | 7-9C | 448 | 18.13 | 2.24 |
| Heptamantane #10 | 7-10 | 448 | 18.15 | 2.24 |
| Heptamantane #11 | 7-11 | 448 | 18.20 | 2.25 |
| Heptamantane #12 | 7-12 | 448 | 18.21 | 2.25 |
| Heptamantane #13A | 7-13A | 448 | 18.29 | 2.26 |
| Heptamantane #13B | 7-13B | 448 | 18.29 | 2.26 |
| Heptamantane #13C | 7-13C | 448 | 18.29 | 2.26 |
| Heptamantane #14 | 7-14 | 448 | 18.32 | 2.26 |

FIG. 8A cont'd

| Higher Diamondoid | Compound Reference Number | M+ (m/z) (Equals Base Peak) | GC/MS Retention Times* (min.) | GC/MS Relative Retention Times** (min.) |
|-------------------|---------------------------|-----------------------------|-------------------------------|---|
| Octamantane #1 | 8-1 | 446 | 17.30 | 2.14 |
| Octamantane #2 | 8-2 | 446 | 17.37 | 2.14 |
| Octamantane #3 | 8-3 | 446 | 17.42 | 2.15 |
| Octamantane #4 | 8-4 | 446 | 17.47 | 2.16 |
| Octamantane #5 | 8-5 | 446 | 17.71 | 2.19 |
| Octamantane #6 | 8-6 | 446 | 17.82 | 2.20 |
| Octamantane #7 | 8-7 | 446 | 17.86 | 2.20 |
| Octamantane #8 | 8-8 | 446 | 18.22 | 2.25 |
| Octamantane #9 | 8-9 | 446 | 18.46 | 2.28 |
| Octamantane #10 | 8-10 | 446 | 18.85 | 2.30 |
| Octamantane #11 | 8-11 | 446 | 18.76 | 2.32 |
| Nonamantane #1 | 9-1 | 498 | 19.86 | 2.45 |
| Decamantane #1 | 10-1 | 456 | 18.57 | 2.29 |
| Decamantane #2 | 10-2 | 496 | 21.33 | 2.63 |
| Undecamantane#1 | 11-1 | 508 | 21.05 | 2.60 |

* HP-MS5 (30m X 0.25 mm, 0.25 micron film), helium carrier gas,

** Reference to Tetramantane #1

FIG. 8B

| Higher Diamondoid | Compound Reference Number | Fraction Number | Elution Time (min.) | Elution Volume (mL) | Elution Volume Relative to 4-1 |
|-------------------|---------------------------|-----------------|---------------------|---------------------|--------------------------------|
| Tetramantane #1 | 4-1 | 4 | 119 | 594 | 1.00 |
| Tetramantane #2 | 4-2 | 7 | 125 | 627 | 1.05 |
| Tetramantane #3 | 4-3 | 6 | 123 | 616 | 1.04 |
| Pentamantane #1 | 5-1 | 11 | 134 | 669 | 1.13 |
| Pentamantane #2 | 5-2 | 19 | 151 | 754 | 1.27 |
| Pentamantane #3 | 5-3 | 28 | 170 | 850 | 1.43 |
| Pentamantane #4 | 5-4 | 22 | 157 | 786 | 1.32 |
| Pentamantane #5 | 5-5 | 19 | 151 | 754 | 1.27 |
| Pentamantane #6 | 5-6 | 20 | 153 | 765 | 1.29 |
| Cyclohexamantane | C-6 | 23 | 159 | 797 | 1.34 |
| Hexamantane #1 | 6-1 | 33 | 181 | 903 | 1.52 |
| Hexamantane #2 | 6-2 | 29 | 172 | 861 | 1.45 |
| Hexamantane #3 | 6-3 | 43 | 202 | 1012 | 1.70 |
| Hexamantane #4 | 6-4 | 33 | 181 | 903 | 1.52 |
| Hexamantane #5 | 6-5 | 35 | 185 | 924 | 1.56 |
| Hexamantane #6 | 6-6 | 63 | 242 | 1211 | 2.04 |
| Hexamantane #7 | 6-7 | 37 | 189 | 945 | 1.59 |
| Hexamantane #8 | 6-8 | 39 | 193 | 967 | 1.63 |
| Hexamantane #9 | 6-9 | 39 | 193 | 967 | 1.63 |
| Hexamantane #10 | 6-10 | 48 | 214 | 1071 | 1.80 |
| Hexamantane #11 | 6-11 | 36 | 187 | 935 | 1.57 |
| Hexamantane #12 | 6-12 | 44 | 205 | 1024 | 1.72 |
| Hexamantane #13 | 6-13 | 36 | 187 | 935 | 1.57 |
| Hexamantane #14 | 6-14 | 39 | 193 | 967 | 1.63 |
| Hexamantane #15 | 6-15 | 45 | 207 | 1036 | 1.74 |
| Hexamantane #16 | 6-16 | 44 | 205 | 1024 | 1.72 |
| Hexamantane #17 | 6-17 | 49 | 217 | 1083 | 1.82 |
| Heptamantane #1 | 7-1 | 45 | 207 | 1036 | 1.74 |
| Heptamantane #2 | 7-2 | 41 | 198 | 989 | 1.66 |
| Heptamantane #3 | 7-3 | 61 | 238 | 1190 | 2.00 |
| Heptamantane #4A | 7-4A | 90 | 304 | 1519 | 2.56 |
| Heptamantane #4B | 7-4B | 90 | 304 | 1519 | 2.56 |
| Heptamantane #5 | 7-5 | 76 | 270 | 1349 | 2.27 |
| Heptamantane #6 | 7-6 | 67 | 251 | 1253 | 2.11 |
| Heptamantane #7 | 7-7 | — | — | — | — |
| Heptamantane #8 | 7-8 | 59 | 234 | 1172 | 1.97 |
| Heptamantane #9A | 7-9A | 60 | 236 | 1181 | 1.99 |
| Heptamantane #9B | 7-9B | 62 | 240 | 1200 | 2.02 |
| Heptamantane #9C | 7-9C | 78 | 274 | 1370 | 2.31 |
| Heptamantane #10 | 7-10 | 86 | 291 | 1455 | 2.45 |
| Heptamantane #11 | 7-11 | — | — | — | — |
| Heptamantane #12 | 7-12 | — | — | — | — |
| Heptamantane #13A | 7-13A | 58 | 233 | 1163 | 1.96 |
| Heptamantane #13B | 7-13B | 74 | 266 | 1328 | 2.24 |
| Heptamantane #13C | 7-13C | 90 | 304 | 1519 | 2.56 |
| Heptamantane #14 | 7-14 | 70 | 257 | 1285 | 2.16 |

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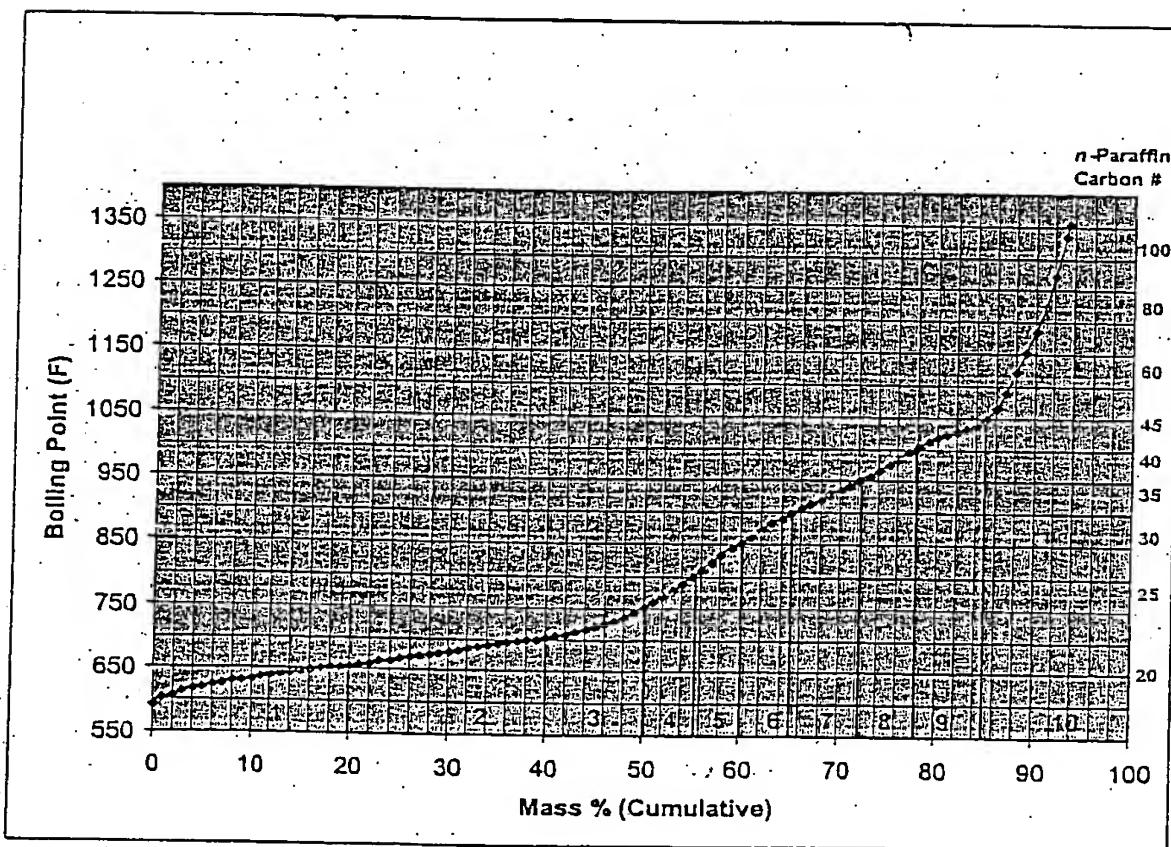
FIG. 8B cont'd

| Higher Diamondoid | Compound Reference Number | Fraction Number | Elution Time (min.) | Elution Volume (mL) | Elution Volume Relative to 4-1 |
|-------------------|---------------------------|-----------------|---------------------|---------------------|--------------------------------|
| Octamantane #1 | 8-1 | 81 | 280 | 1402 | 2.36 |
| Octamantane #2 | 8-2 | 83 | 285 | 1423 | 2.40 |
| Octamantane #3 | 8-3 | 64 | 244 | 1221 | 2.06 |
| Octamantane #4 | 8-4 | — | — | — | — |
| Octamantane #5 | 8-5 | 63 | 242 | 1211 | 2.04 |
| Octamantane #6 | 8-6 | 79 | 276 | 1381 | 2.32 |
| Octamantane #7 | 8-7 | 71 | 259 | 1296 | 2.18 |
| Octamantane #8 | 8-8 | 84 | 287 | 1434 | 2.41 |
| Octamantane #9 | 8-9 | 74 | 266 | 1328 | 2.24 |
| Octamantane #10 | 8-10 | 80 | 280 | 1402 | 2.36 |
| Octamantane #11 | 8-11 | 85 | 289 | 1445 | 2.43 |
| Nonamantane #1 | 9-1 | 89 | 297 | 1487 | 2.50 |
| Decamantane #1 | 10-1 | 83 | 285 | 1423 | 2.40 |
| Decamantane #2 | 10-2 | — | — | — | — |
| Undecamantane#1 | 11-1 | 101 | 355 | 1774 | 2.99 |

ODS HPLC Whatman ODS-II 10/50
(2 Columns in series), acetone mobile phase @5.0 mL/min.

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FIG. 9



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FIG. 10

| | |
|-------------------|--|
| Higher Diamondoid | |
| Tetramantanes | |
| Pentamantanes | |
| Cyclohexamantanes | |
| Hexamantanes | |
| Heptamantanes | |
| Octamantanes | |
| Nonamantanes | |
| Decamantanes | |
| Undecamantanes | |

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FIG. 11A

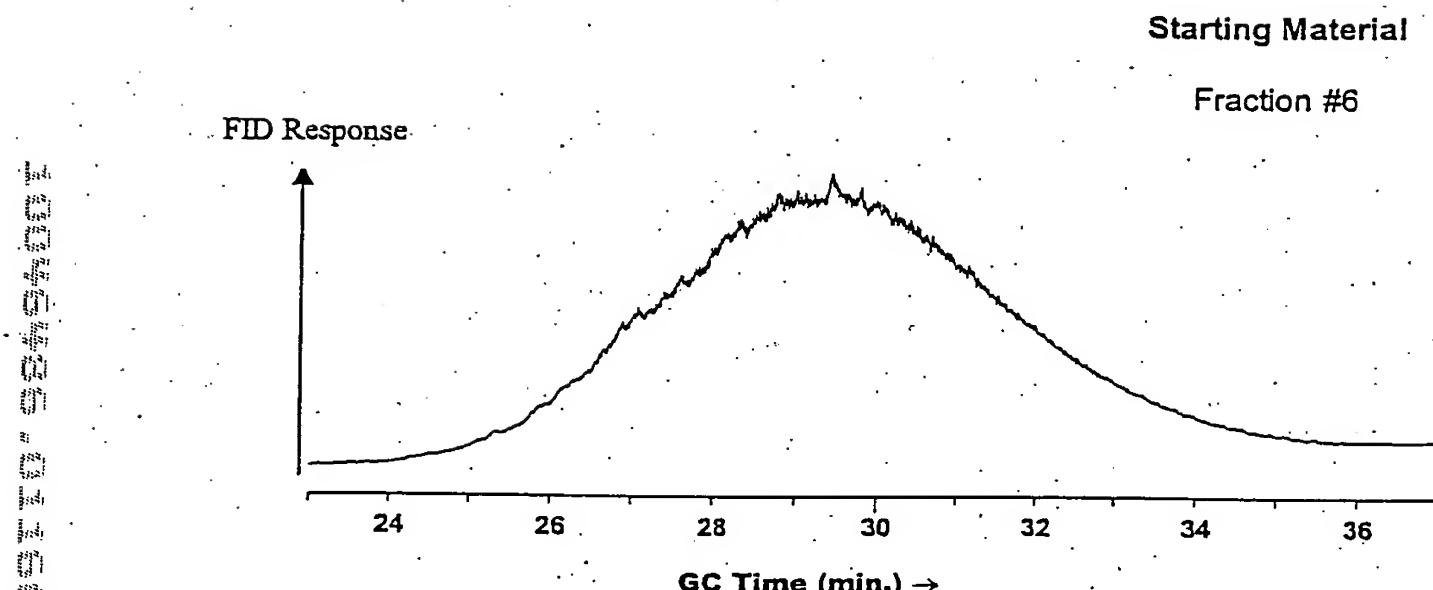
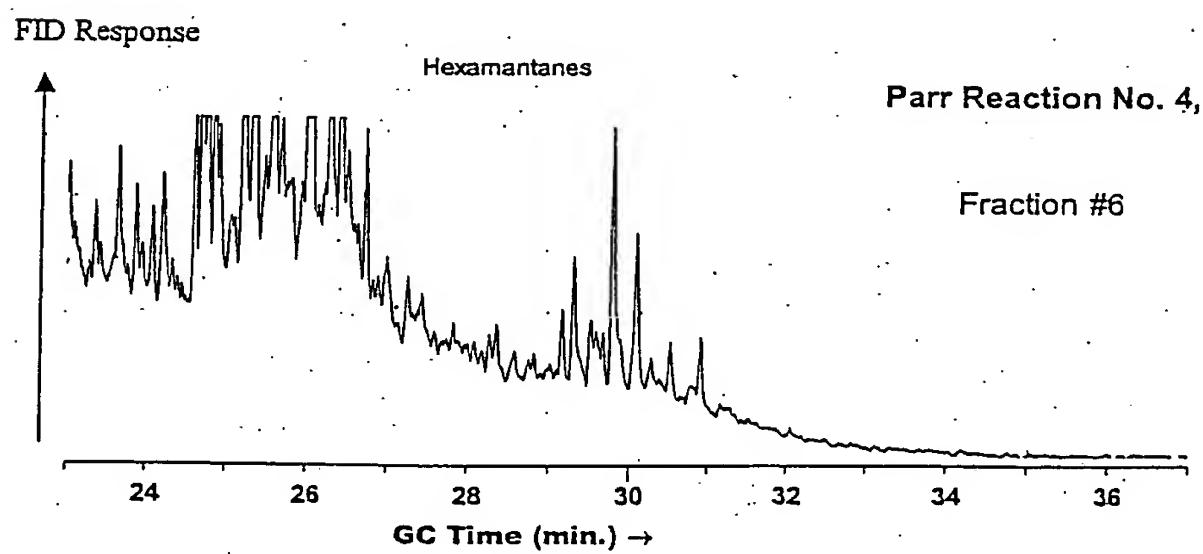


FIG. 11B



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FIG. 12A

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FIG. 12B

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FIG. 13A

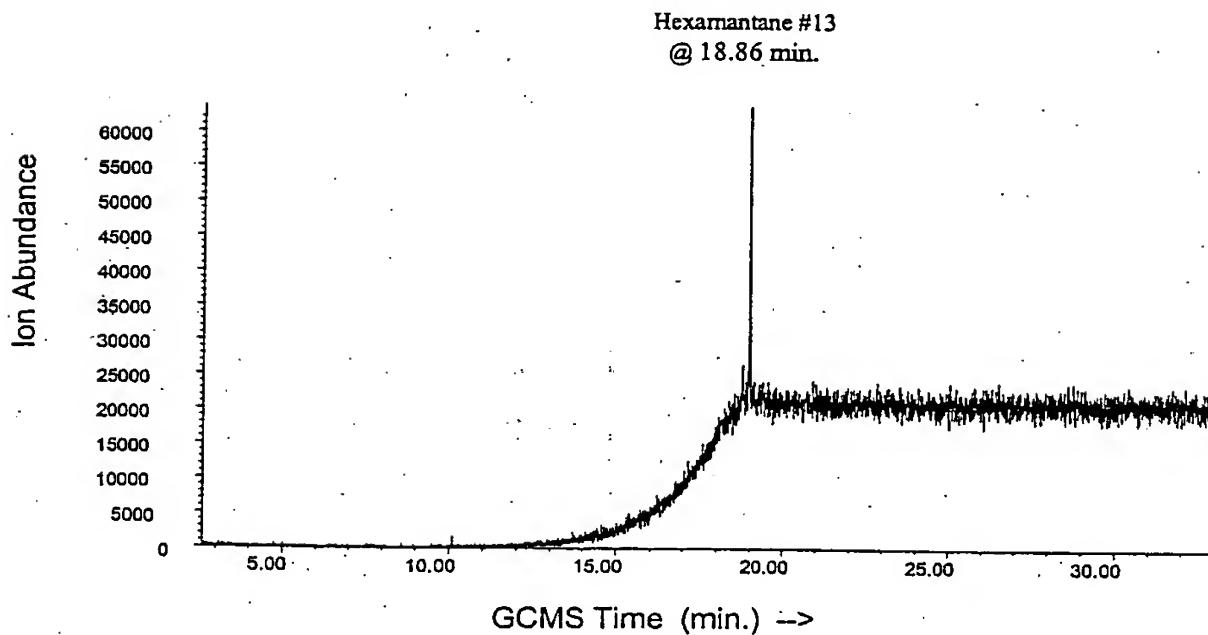


FIG. 13B

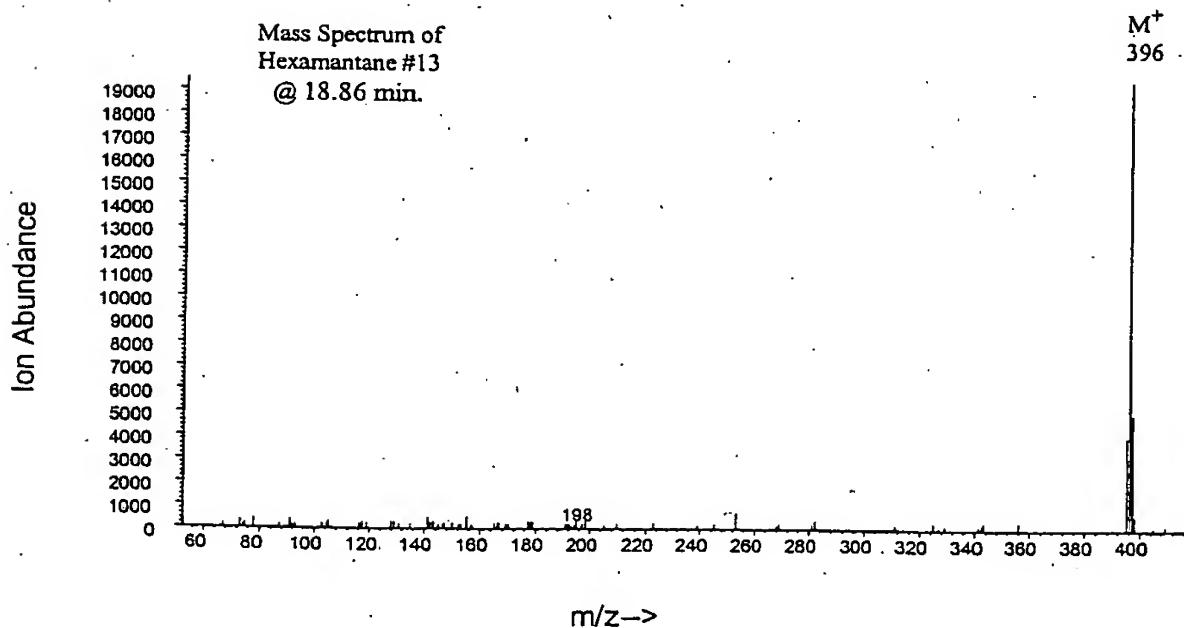


FIG. 14A

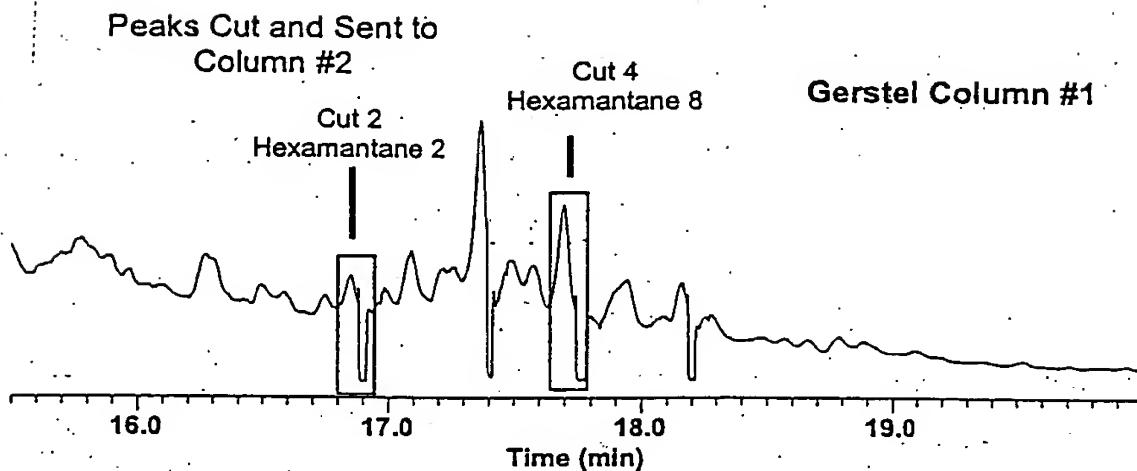
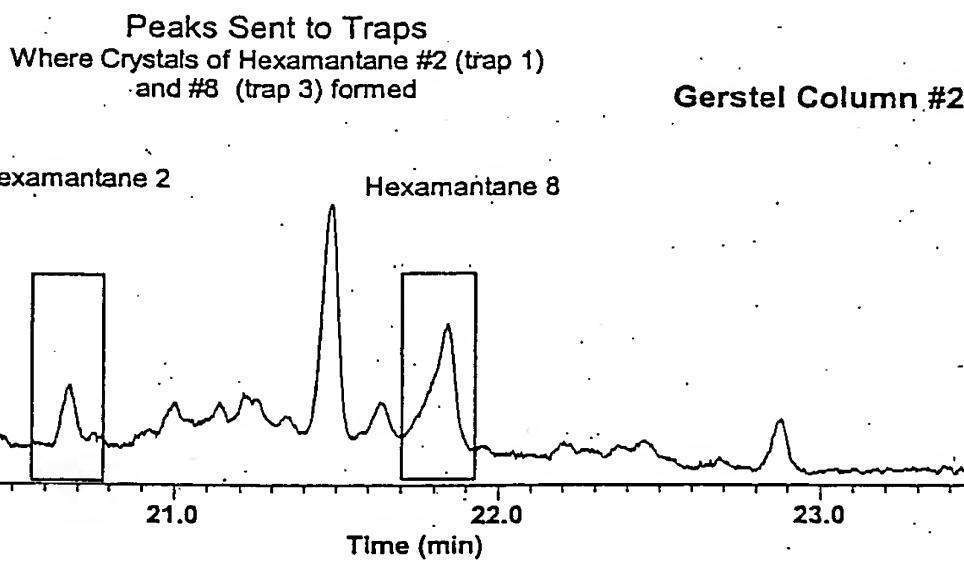


FIG. 14B



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FIG. 15A

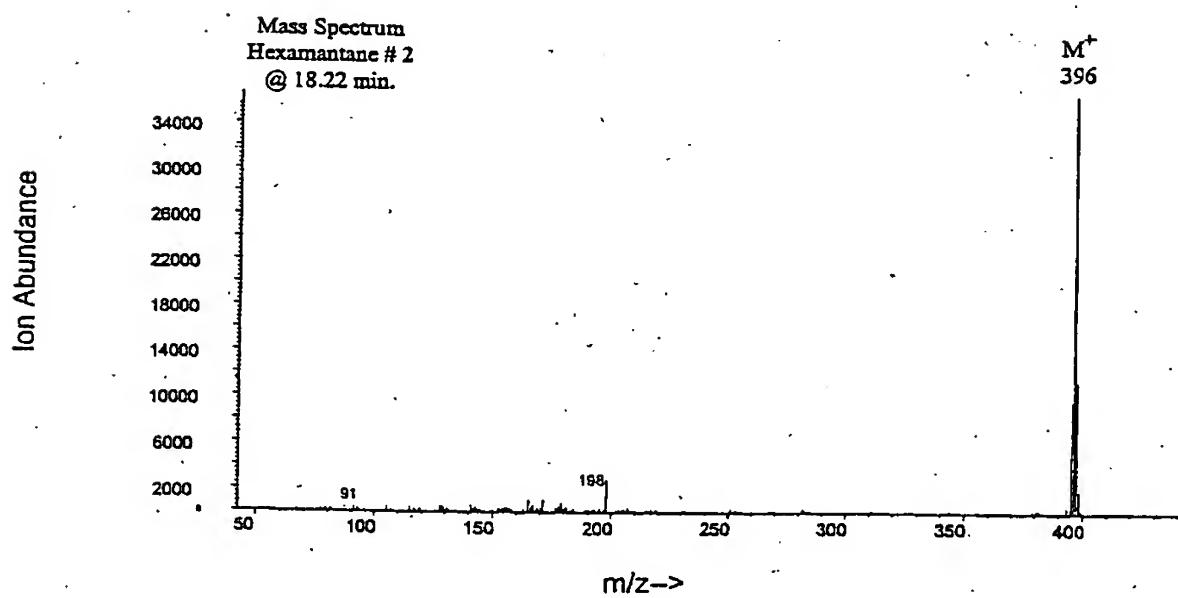
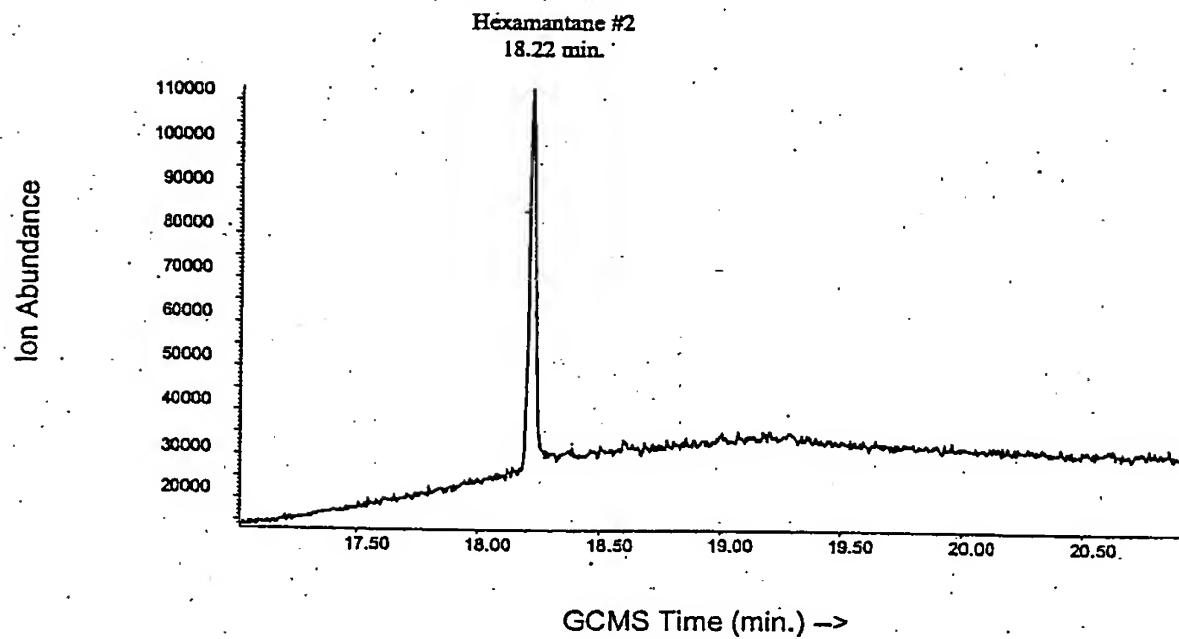


FIG. 15B

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FIG. 15C

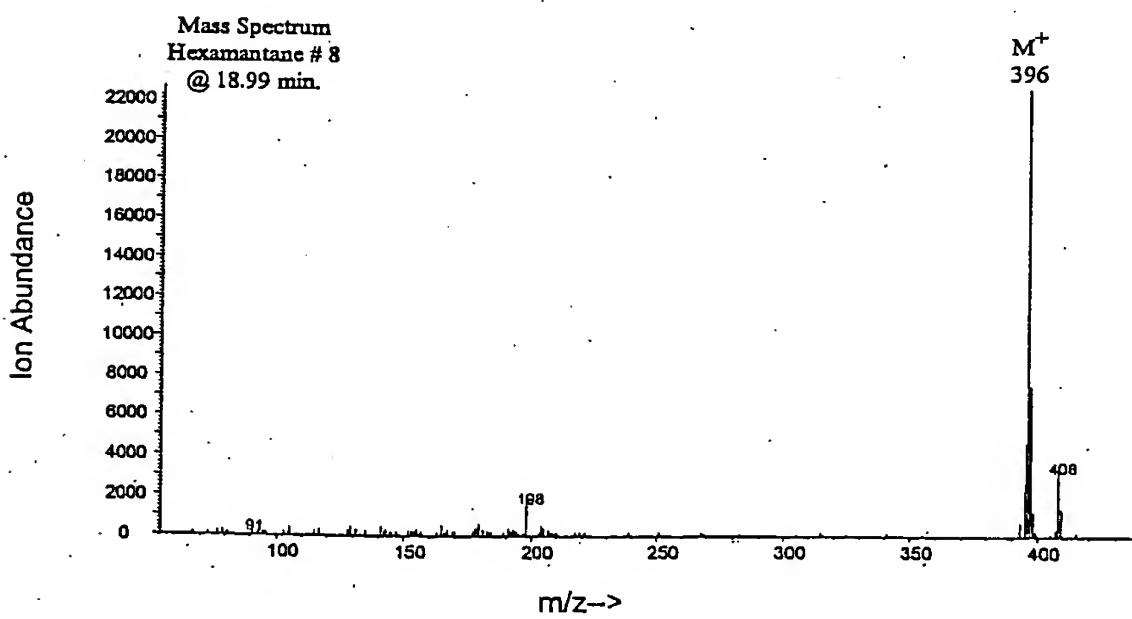
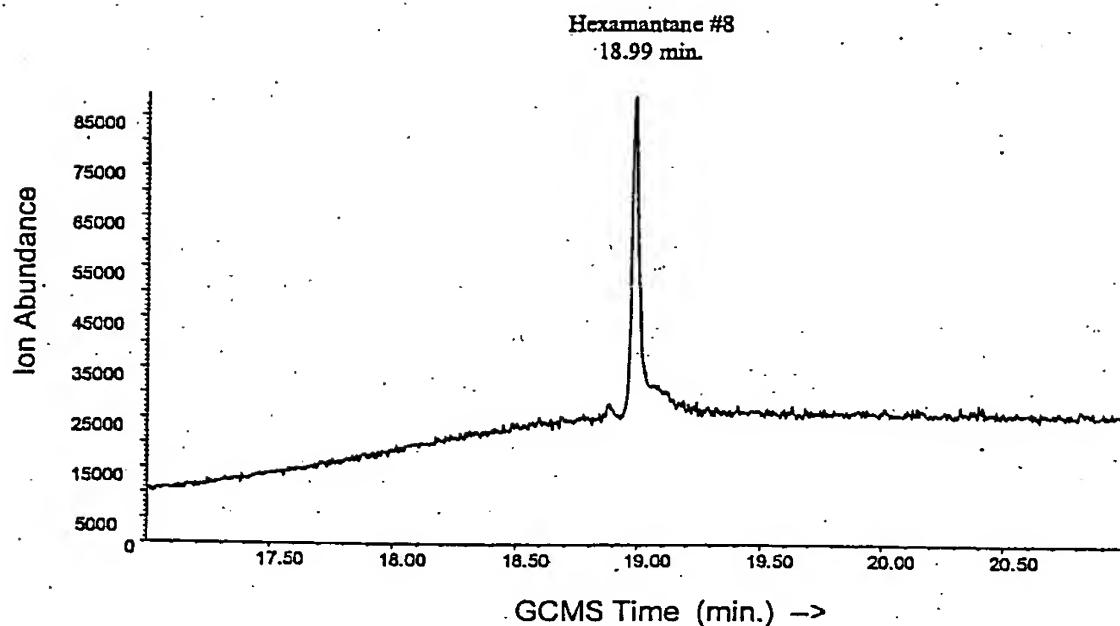
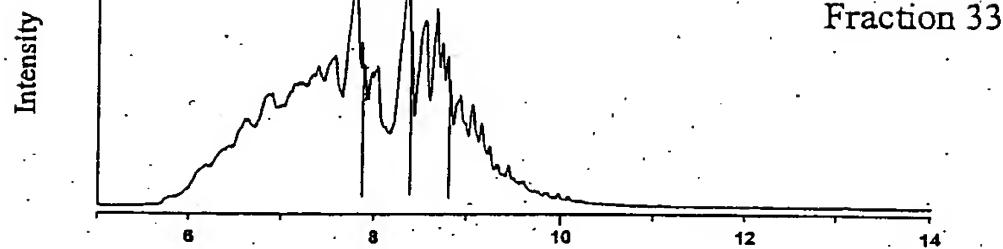


FIG. 15D

FIG. 16

First
Column



Second
Column

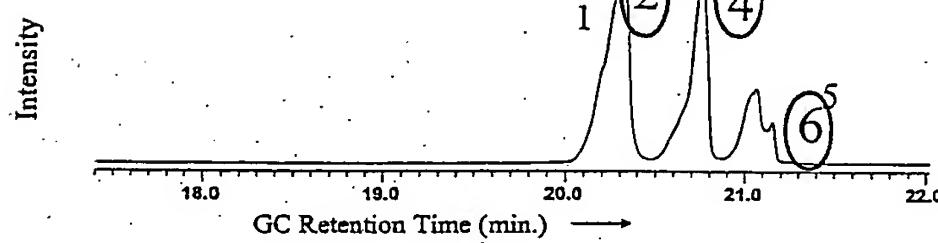


FIG. 17

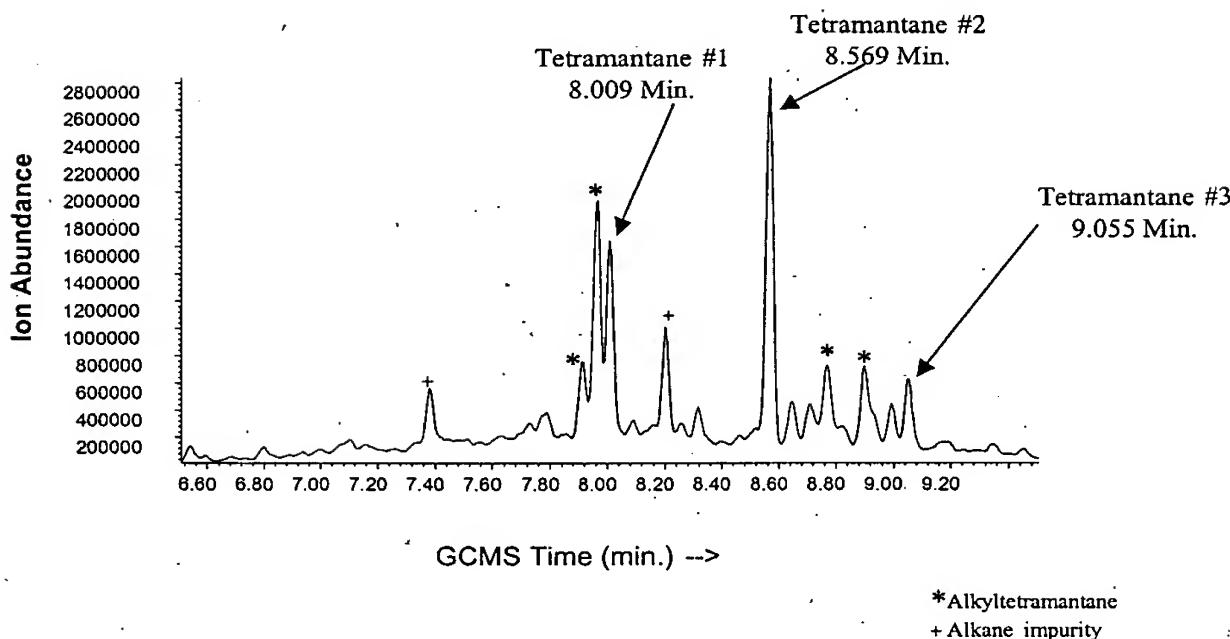
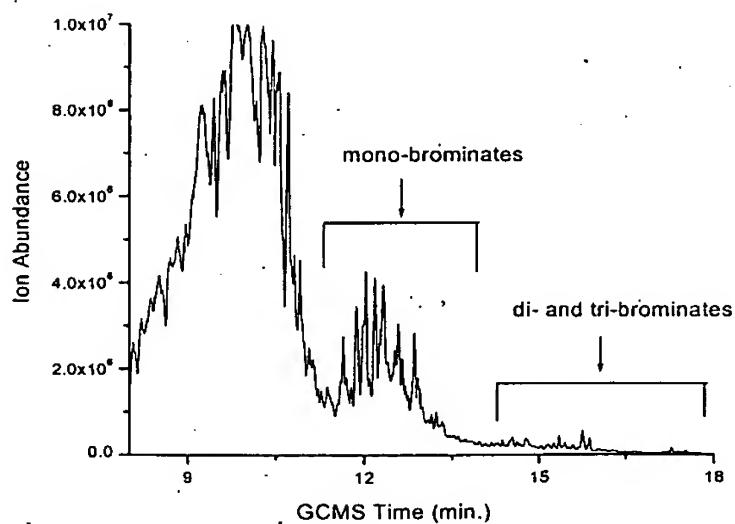


FIG. 18

TIC of Bromination Products of a Feedstock Containing a Mixture of Tetramantanes and Alkyltetramantanes



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FIG. 19

TIC of Mono-brominated Products

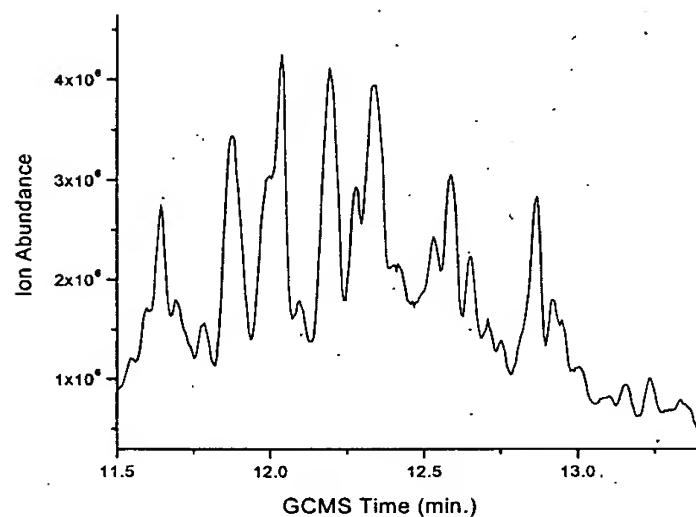
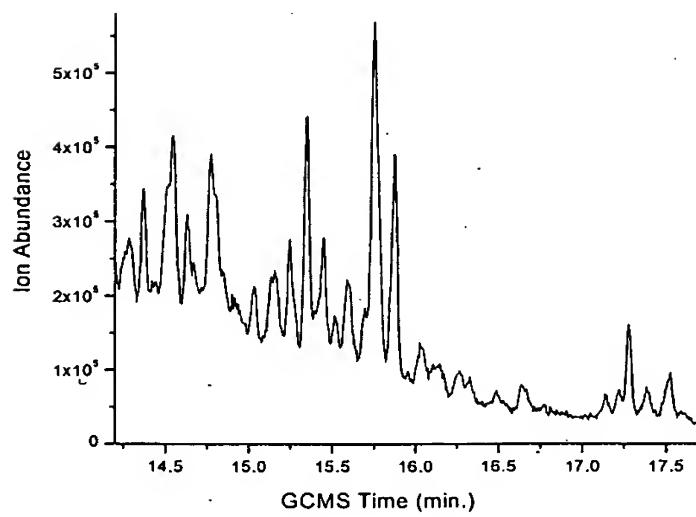


FIG. 20

TIC of Di- and Tri-brominated Products



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FIG. 21

GC of a Mono-brominated Tetramantane (•, 12.038 min.)

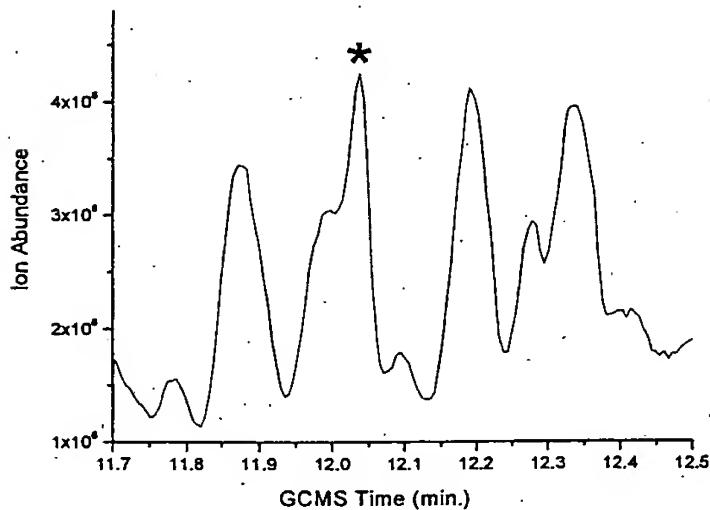
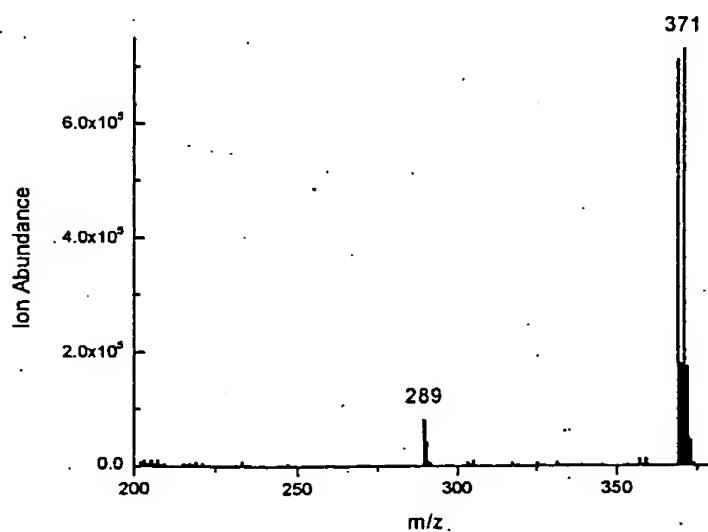


FIG. 22

GCMS of the Mono-brominated Tetramantane @ 12.038 min.



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FIG. 23

GC of Mono-brominated Methyltetramantanes (•, 11.644 and 11.992 min.)

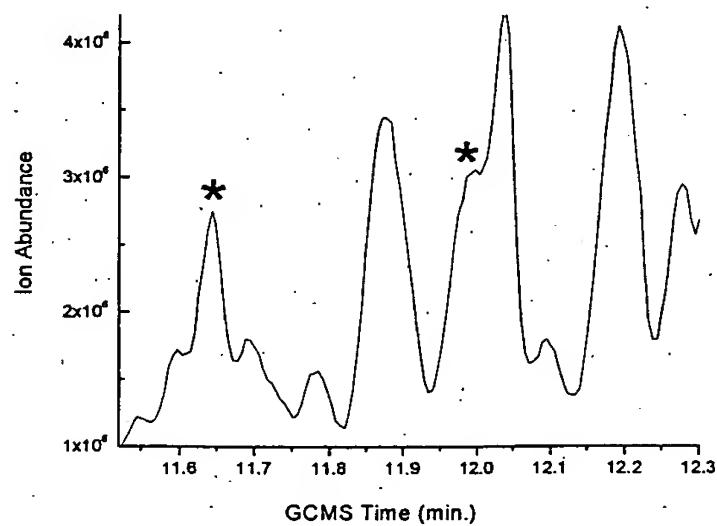
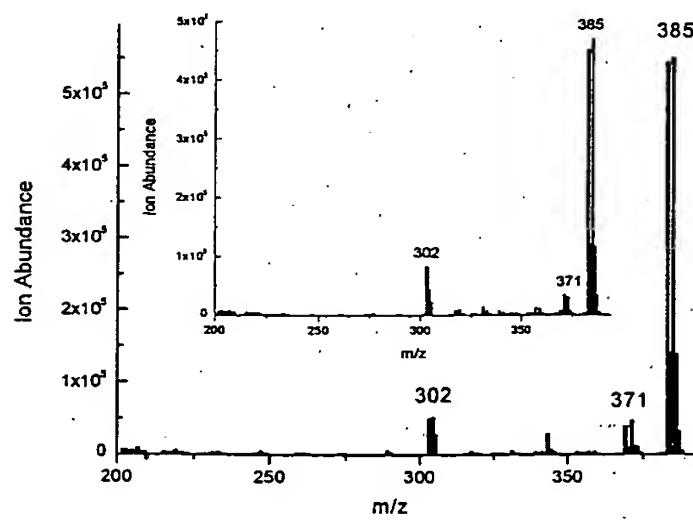


FIG. 24

GCMS of the Monobrominated Methyltetramantanes @ 11.644 (inset) and 11.992 min.



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FIG. 25

GC of a Mono-brominated Dimethyltetramantane (, 12.192 min.)

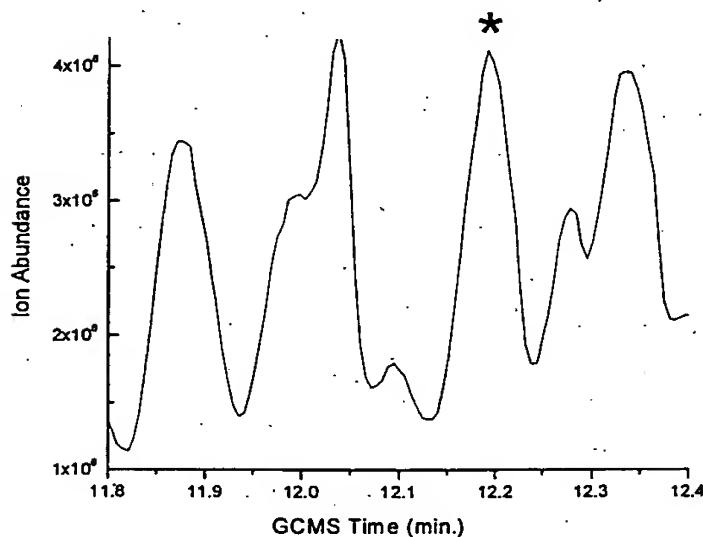


FIG. 26

GCMS of the Monobrominated Dimethyltetramantane @ 12.192 min.

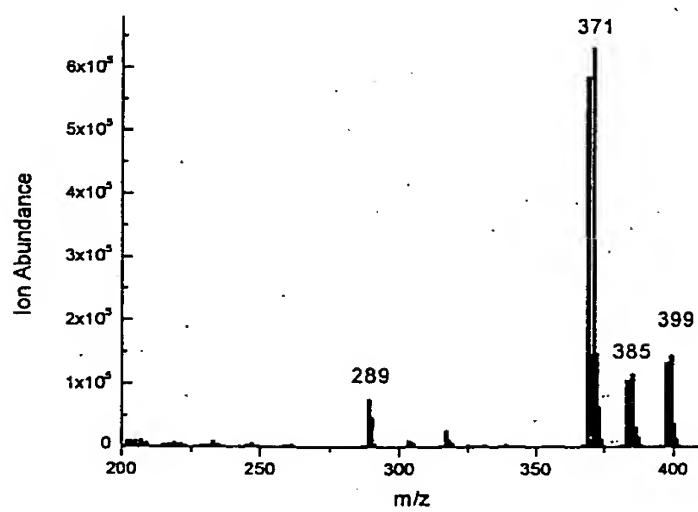


FIG. 27

GC of a Di-brominated Tetramantane (., 15.753 min.)

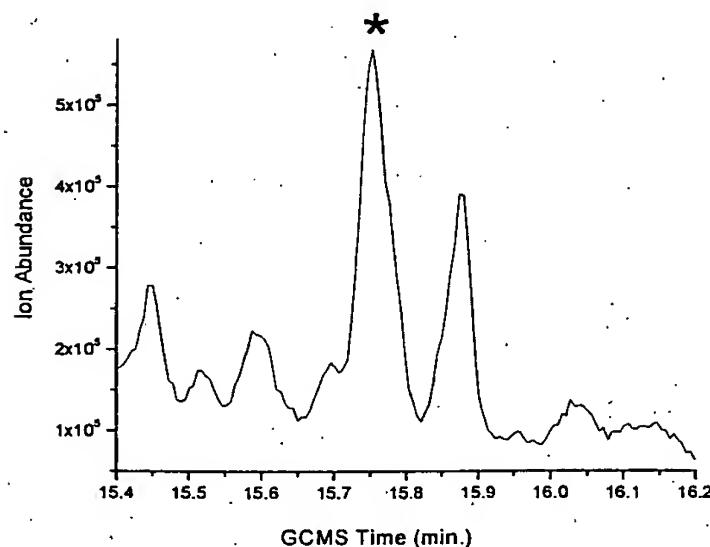
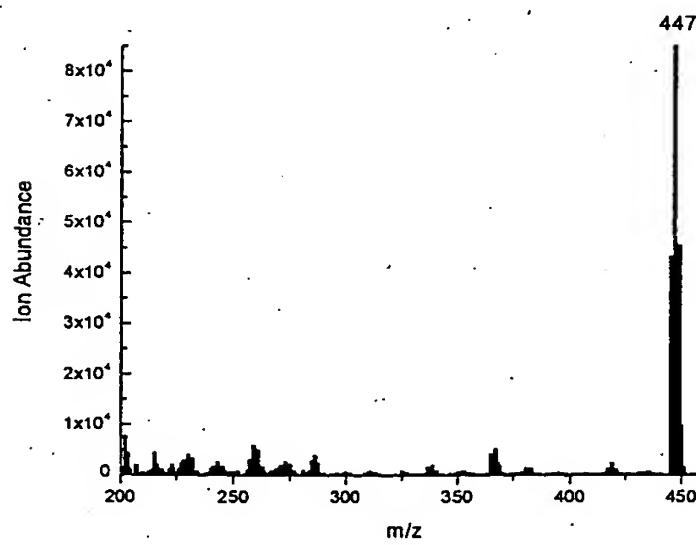


FIG. 28

GCMS of the Di-brominated Tetramantane @ 15.753 min.



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FIG. 29

GC of a Di-brominated Methyltetramantane (*, 15.879 min.)

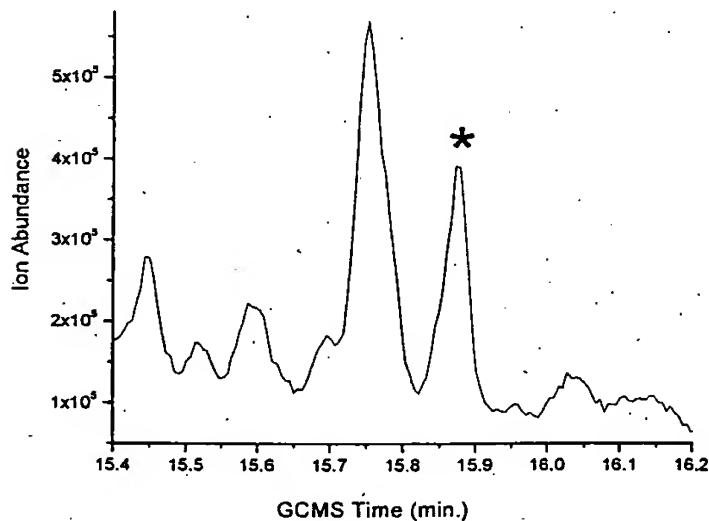
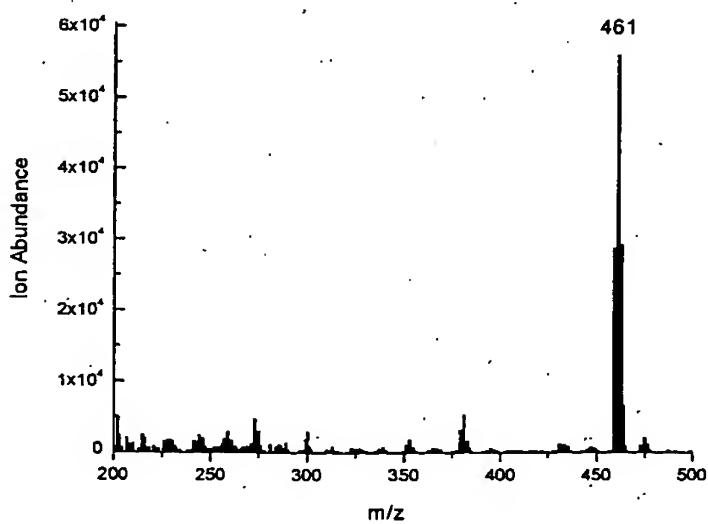


FIG. 30

GCMS of the Di-brominated Methyltetramantane @ 15.879 min.



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FIG. 31

GC of a Tri-brominated Tetramantane (*, 17.279 min.)

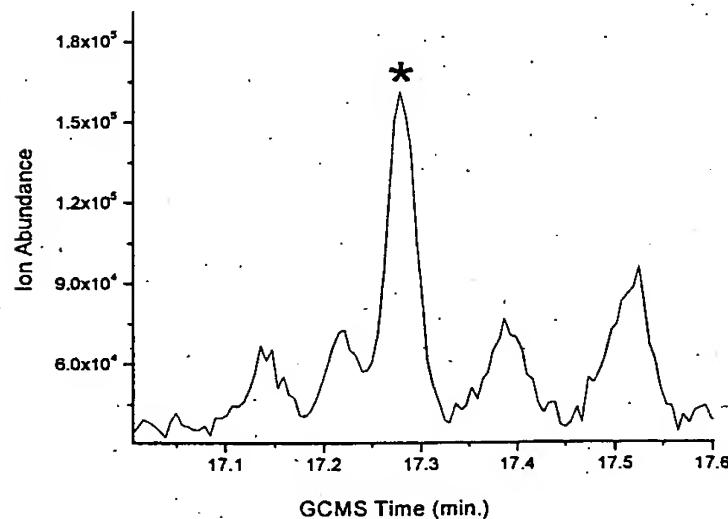
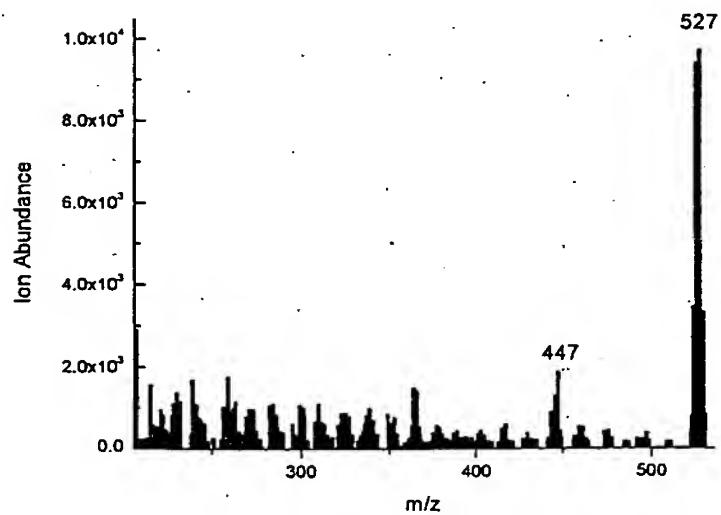


FIG. 32

GCMS of the Tri-brominated Tetramantane @ 17.279 min.



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FIG. 33

GC of a Tri-brominated Methyltetramantane (*, 15.250 min.)

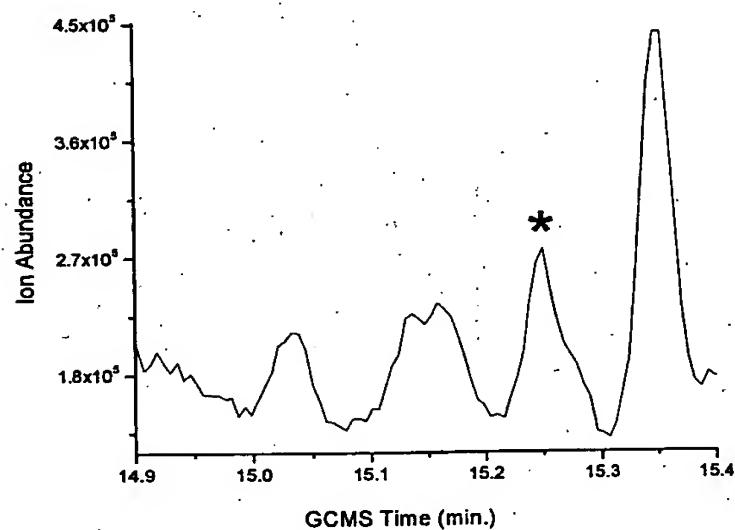


FIG. 34

GCMS of the Tri-brominated Methyltetramantane @ 15.250 min.

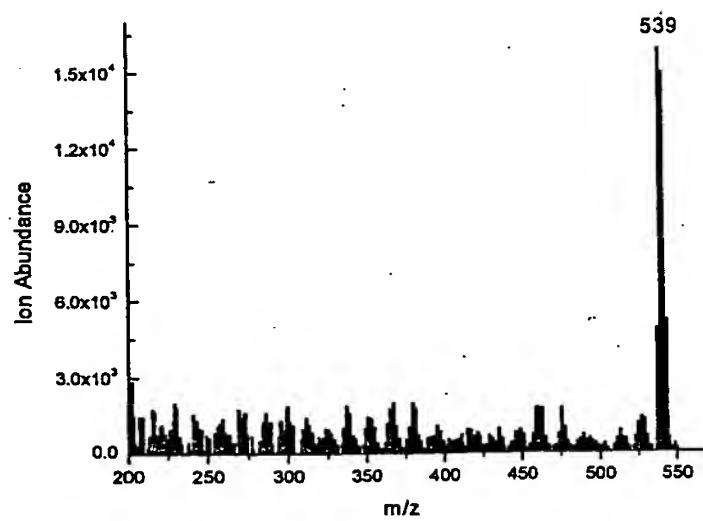


FIG. 35

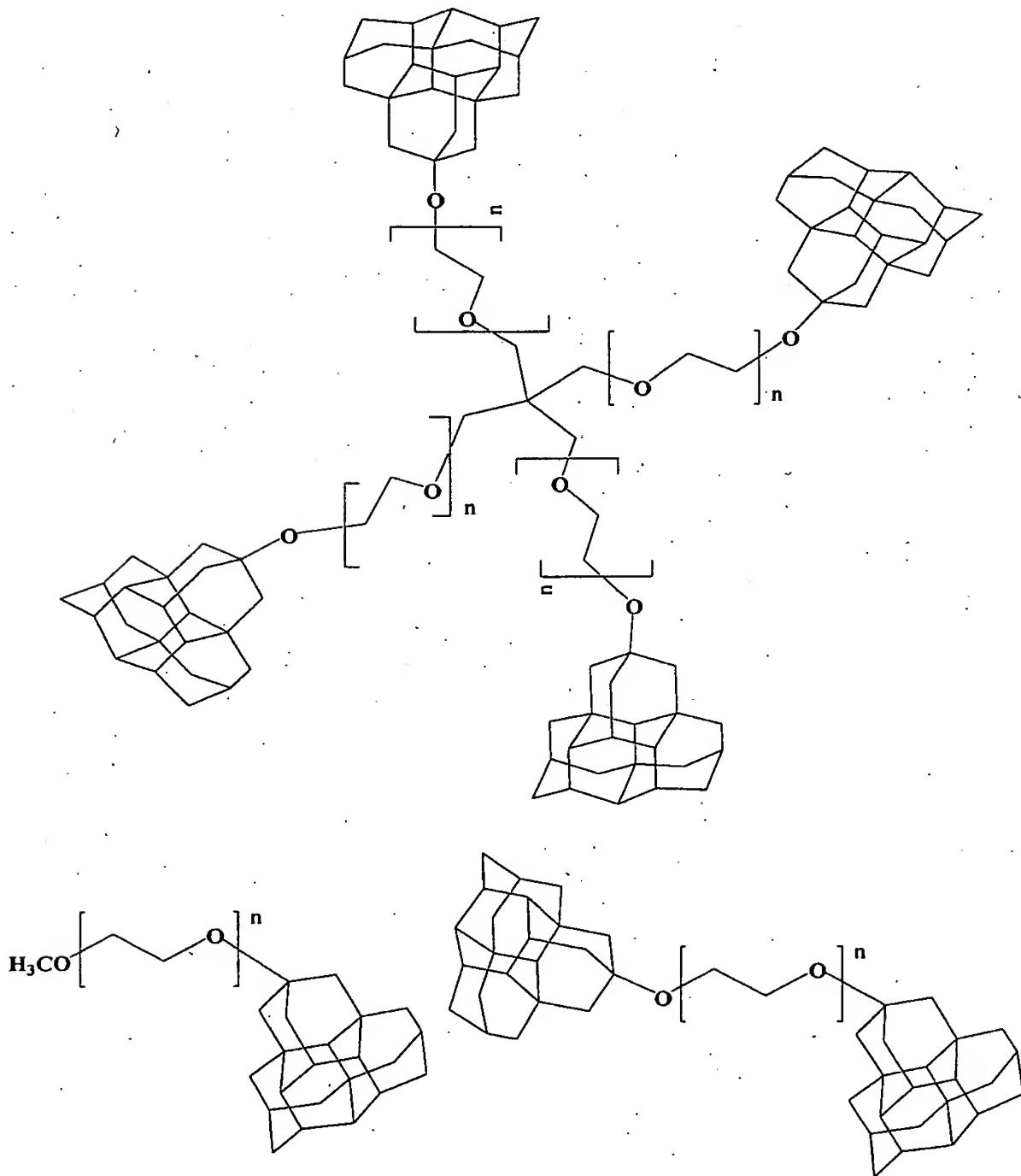
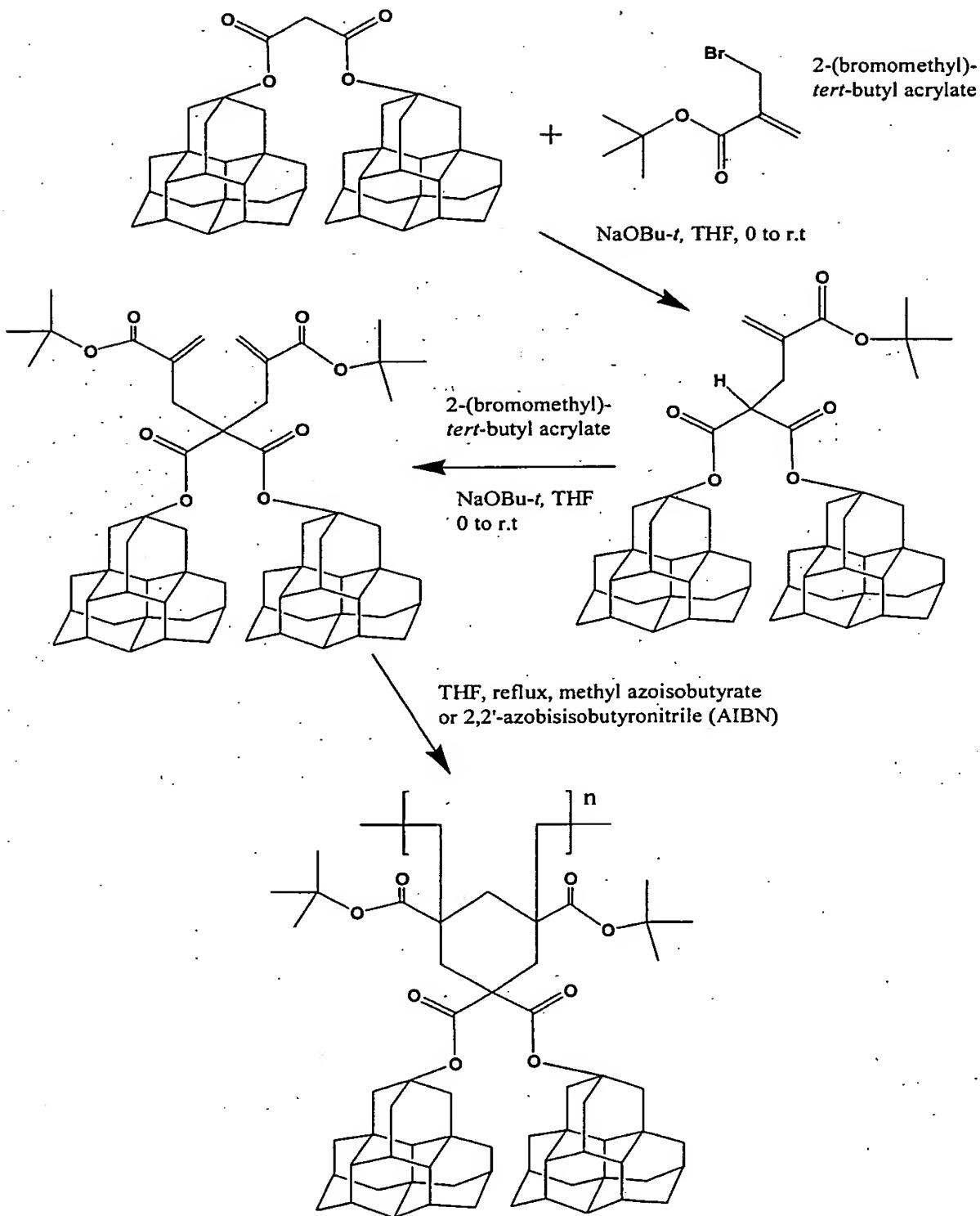


FIG. 36

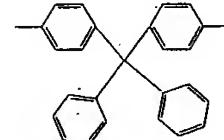
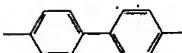
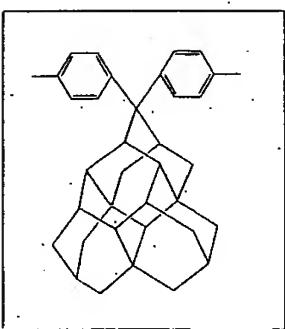
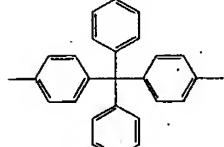
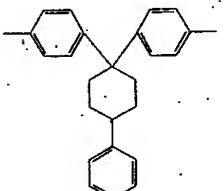
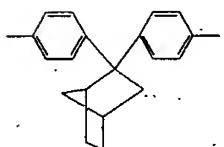
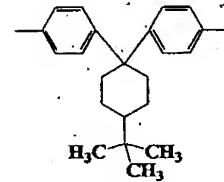
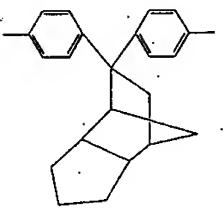
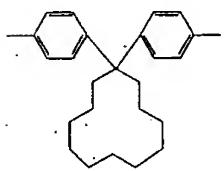
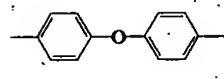
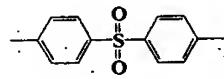
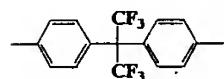


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FIG. 37A

Aromatic bisphenols: HO-Ar-OH

Ar:



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FIG. 37B

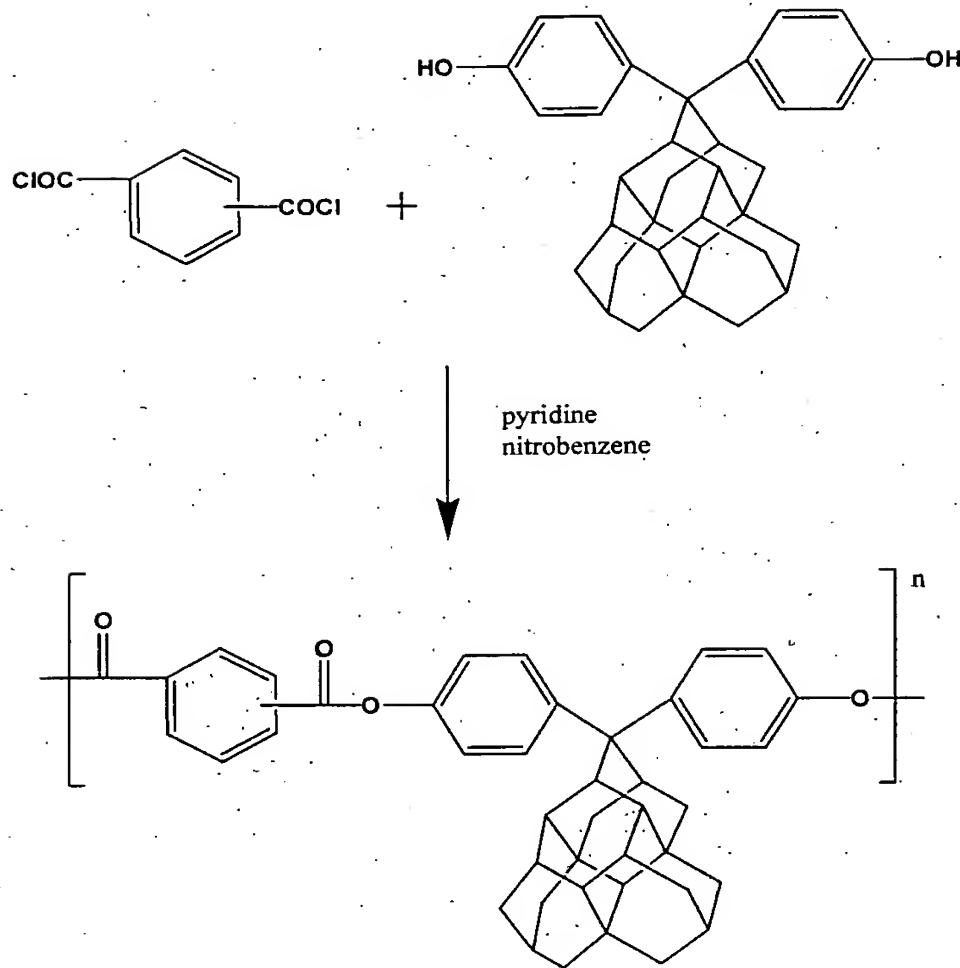
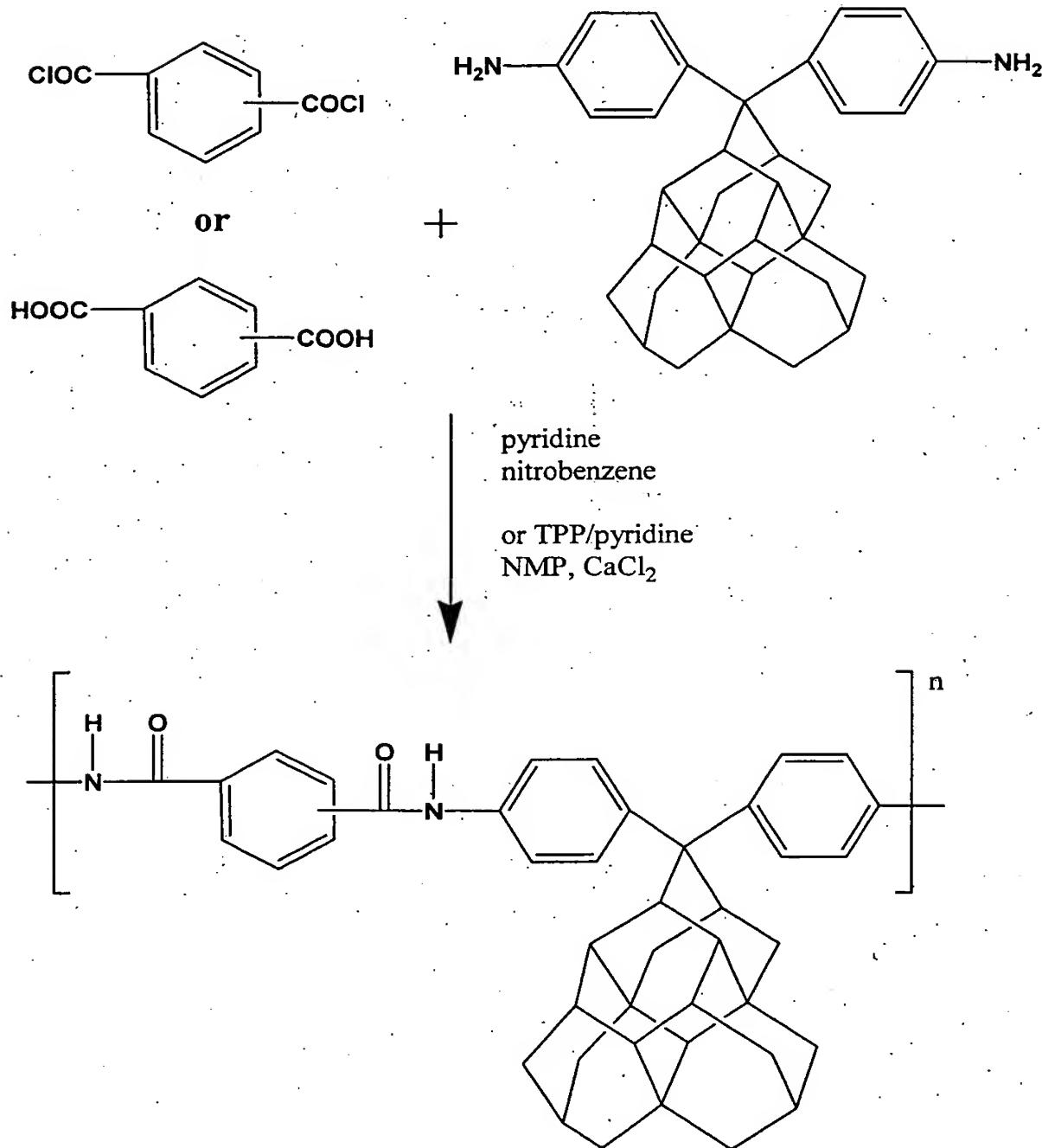
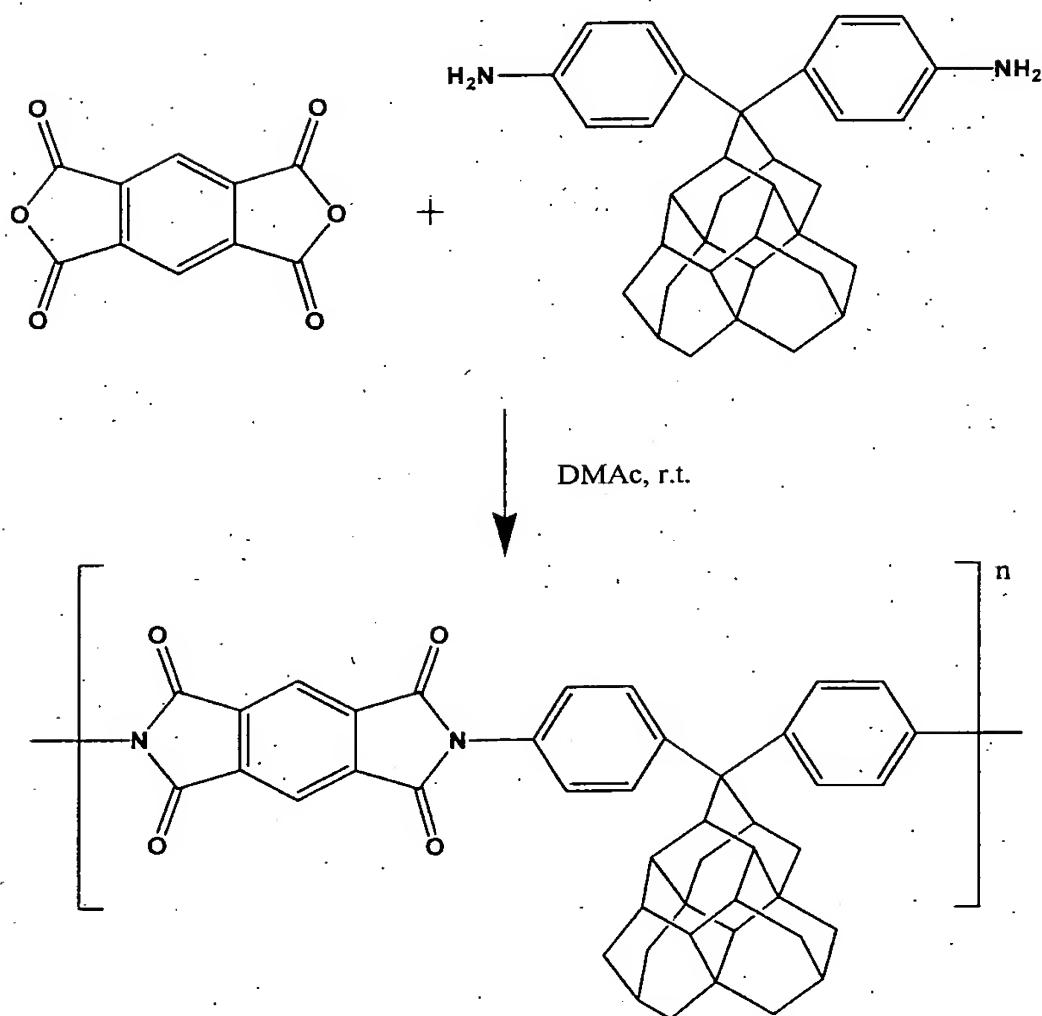


FIG. 38



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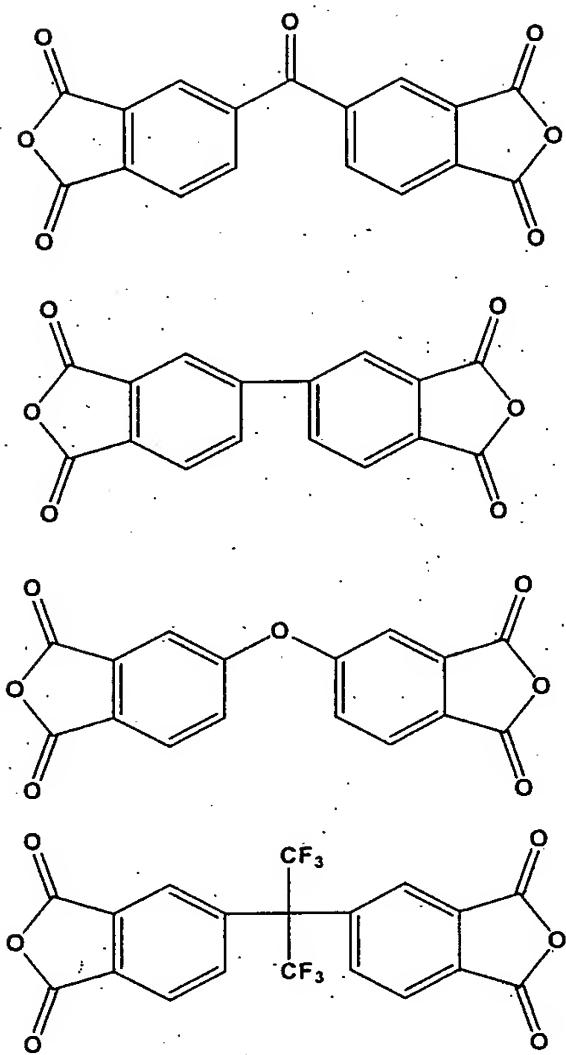
FIG. 39A



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FIG. 39B

Aromatic Dianhydride



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FIG. 40

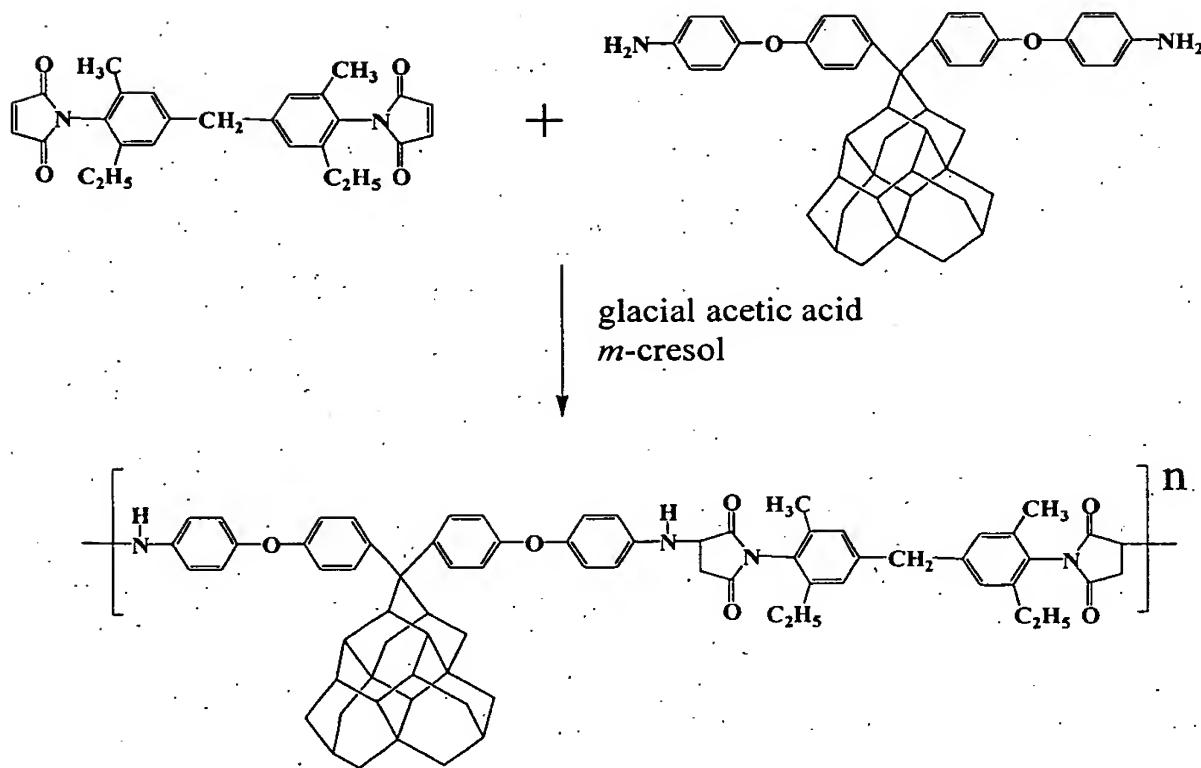


FIG. 41

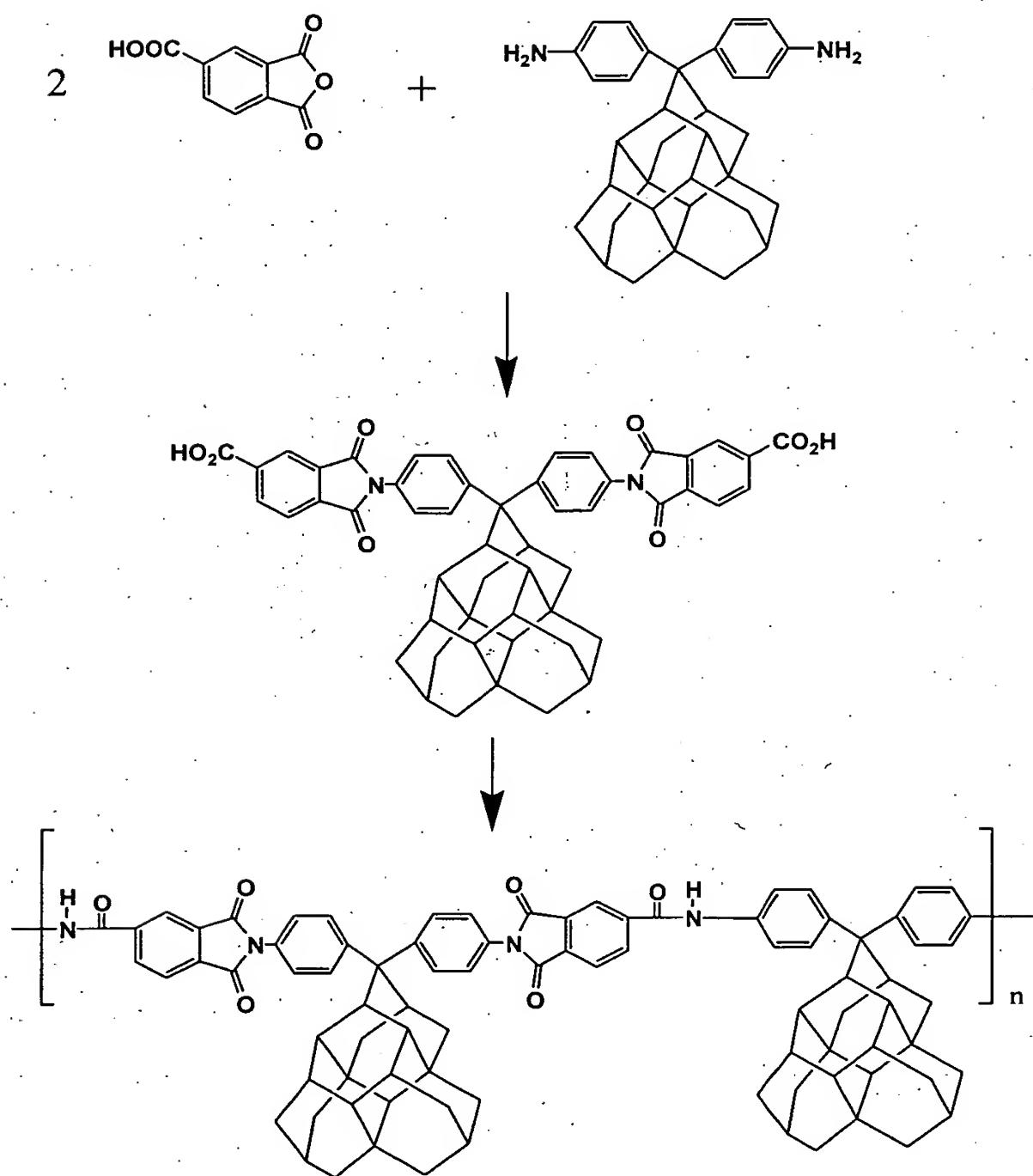


FIG. 42

Aromatic diamines: $\text{H}_2\text{N}-\text{Ar}-\text{NH}_2$

Ar:

